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ABSTRACT

A study of science teaching insecurity in preservice elementary school teachers (N=56) in Finland is presented. Based upon Maslow's theory of basic needs, it was believed that individuals who feel insecure about science or science teaching cannot function at a higher need level until these insecurities are met. A 20-item instrument was used to determine an individual's self-estimated proficiency in science (SEPS), the main independent variable. Half of the students with low SEPS and half with high SEPS took a "traditional" methods course which emphasized basic competencies in teaching physical science. The other half of each group took a "humanistic" methods course which emphasized self actualization. It was hypothesized that the traditional course would best suit students with low SEPS and the humanistic course would be better for those with high SEPS. Two other independent variables included 1) actual proficiency in science (APS) as determined by an achievement test in high school physics and chemistry and 2) sex. Instruments designed to measure absolute and relative levels of anxiety specific to the teaching of science (ASTS, RATS) were administered. Findings indicate that neither of the method courses was superior to the other, based upon ASTS and RATS scores. (DC)

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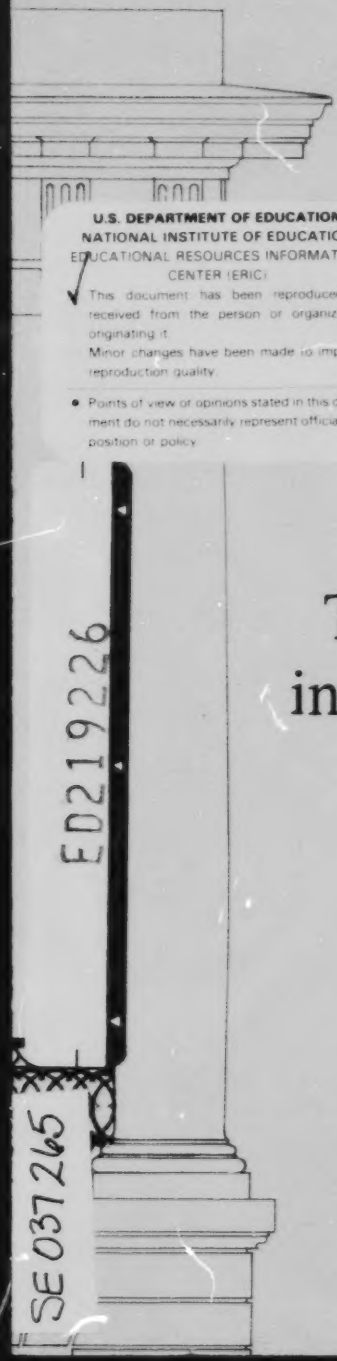

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Preservice Teacher Education in Elementary Science

OLE BJÖRKQVIST

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Preservice Teacher Education in Elementary Science

The effect of methods courses emphasizing self-actualization and basic competencies on anxiety specific to the teaching of physical science at the elementary level

OLE BJÖRKQVIST

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Preservice Teacher Education in Elementary Science

The effect of methods courses emphasizing self-actualization and basic competencies on anxiety specific to the teaching of physical science at the elementary level

By

OLE BJÖRKQVIST

A dissertation submitted to the Graduate School
in partial fulfillment of the requirements
for the degree
Doctor of Education

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CHAPTER I

Introduction

Teacher education in Finland has recently gone through two major revolutions (Kähkönen, 1979). In 1973-1974, the preparatory education of elementary school teachers, previously given in seminaries, was given academic status and taken into the university programs. A number of new faculties (sections within universities) were founded to replace the old seminaries and to become teacher education centers in general. In a few cases these faculties are located away from their mother universities, for reasons of regional balance.

Starting in 1978, and gradually taking effect, a general "reform of academic examina" brought additional change. This involves a transition from free academic studies, traditional in most of Europe, to educational programs set up specifically to meet the needs of society. The educational programs are meant to cut down the time wasted on unproductive studies and to give the university student a broader education where one formerly specialized very early. The extension of the rearrangements varies with the degree aimed at, being small, e.g., for students of medicine or engineering. In teacher education, however, the change will again be clearly noticeable. The education of elementary teachers has been lengthened to a minimum of four years (from three) and will lead to the new degree, "master of pedagogy"; the new requirements include the presentation of a master's thesis. Secondary teachers, in general, will no longer take their studies in education after completing their subject studies, but will aim for a teaching career through their university studies.

Changes in organization must be reflected at the instructional level, but with the imposed rate of change there clearly has not been time to develop courses in complete agreement with the philosophy behind the changes. In most cases, there thus remains the problem of developing courses based on

sound educational theories, applicable to the new situation. This work must largely be done by the university teachers themselves, regardless of their background in educational research. In cases where one can rely on experience from abroad, work may be expected to be speeded up. This study, consequently, is an attempt to apply theories and results produced in the United States to a particular situation in Finland.

The Problem

The subjects of physics and chemistry do not have a long tradition in the elementary school curriculum in Finland. It was not until the introduction of the fundamental (basic) school in 1970 that the subjects were taught at each of the three highest grades (to students aged 13-16), and even then usually only 2-3 hours a week. In the lowest grades, at the "elementary" level, a subject called environmental studies has a much longer tradition and includes elements of biology and social studies. In 1970, the proportion of physics and chemistry within environmental studies was increased. During the third and fourth school year, "environmental studies" was almost synonymous with physics and chemistry, but was still taught for only one hour a week (*Grundskolans läroplanskommittés betänkande II*, 1970).

In an international comparison, Finnish students receive relatively little instruction in physics and chemistry, and up until very recently they have also experienced an unnatural break during their fifth and sixth school year, when no physics or chemistry has been offered (Makkonen & Makkonen, 1974). The importance of the receptiveness during those years has been brought forward, and a gradual spreading of instruction formerly concentrated on the third and fourth year has been initiated, but it will not involve an increase in the overall instruction in physics and chemistry (*Omgivningslära. Lärokurs och läroplansanvisningar*, 1979).

However, the change in content from before 1970 has been considerable. This change has had the effect that older elementary school teachers in particular are ill at ease with teaching subject matter related to physics and chemistry. The central school authorities of Finland have been aware of the attitudes and taken them into account in their in-service training at teacher meetings (e.g., Markkula, 1977), but unfortunately the opportunities to

influence active teachers are very limited. The matter is not eased by the international trend toward alienation between scientists and non-scientists commonly referred to as an existence of "two cultures" (Snow, 1961). Elementary school teachers traditionally have little training in physical science, and finding an understanding of the world of science is not always easy.

Beginning teachers are not bound to any traditional program of elementary school science instruction, but the gap between science-oriented and their opposites is nevertheless present. One may speculate with Roszak (1969) and others whether this is a reaction to the accelerated advances of technology or not. In Finland, the relative number of high school (gymnasium) students choosing the elective subject of physics has decreased considerably during the 1970s (Kuitunen, 1980). Students going into elementary school teacher training are thus apt to feel they do not master physical science, even though their actual knowledge of it is not likely to be worse than for teachers in service.

A study conducted by the researcher in 1979 corroborated this general impression. Responses from a group of students finishing their first year of studies in elementary education at the Faculty of Education at Åbo Akademi, Vasa, Finland, showed physics and chemistry (in their program regarded as one subject) to be among those subjects they felt the most insecure about from the viewpoint of teaching. Using the method of forced comparisons and counting the number of times various subjects were chosen as the one entailing more insecurity, the average results for the 15 subjects used were those accounted for in Table 1.

It is to be noted that the study was conducted after some methods instruction had been given, including the very short course (14 hours) in the teaching of physics and chemistry. Although no formal sex discrimination is at hand, it is not possible to take methods courses in both textile and technical handicrafts.

The following year brought about the reform of examina. The additional year given to elementary school teacher education made possible an extension of the methods course in physics and chemistry to 42 hours, to be given during the spring semester of the first year. The study using forced comparisons was repeated at the end of the semester. The results with respect to physics and chemistry are compared with those of 1979 in Table 2.

Table 1

Average Number of Choices of Various Subjects as the One Entailing Greater Insecurity with Respect to Teaching, in Forced Pairwise Comparisons Among 15 Subjects

Subject	Students Responding		
	Female (28)	Male (14)	All (42)
Technical handicrafts	12.29	5.29	9.95
Physics/chemistry	10.04	9.29	9.79
Finnish	9.54	9.93	9.67
Religion	8.64	10.64	9.31
Textile handicrafts	6.82	13.00	8.88
Music	9.14	6.93	8.40
History	7.64	6.21	7.17
Mathematics	6.46	7.43	6.79
English	6.36	6.71	6.48
Geography	6.46	3.79	5.57
Social studies	4.64	6.50	5.26
Swedish	4.25	6.86	5.12
Drawing	4.93	4.93	4.93
Biology	4.79	4.21	4.60
Gymnastics	3.00	3.29	3.10

Table 2

Average Number of Choices of Physics/Chemistry as the Subject Entailing Greater Insecurity of Teaching, in Forced Pairwise Comparisons with 14 Other Subjects

	1979	(*n*)	1980	(*n*)
Female students	10.04	28	10.80	15
Male students	9.29	14	6.73	11
All students	9.79	42	9.08	26

The longer course, given by a different teacher but basically using the same principles as in 1979, shows a different result only with respect to the male students. It may be inferred, as suggested by Table 1 alone, that sex is a variable of importance in dealing with subject preferences of the type considered. The effect of a longer course is not evident.

Altogether the situation is not satisfactory as far as attitudes toward the teaching of physics and chemistry go. Experienced teachers are disturbed by the changing curricula, and the teacher candidates, especially the female ones, continue to consider physics and chemistry difficult subjects to teach. If anything positive is to be done about the situation, the best preservice opportunity is to do it in connection with the methods course. Practice teaching is limited to a certain number of subjects, which means that only about a third of the teacher candidates actually teach physics and chemistry before they get their degree.

Against this background, the problem which the present study is concerned with is how to use the time reserved for a methods course in physics and chemistry most efficiently, so that its impact on prospective elementary school teachers is the greatest possible, within the organizational setting, toward seeing the teaching of physics and chemistry as personally rewarding rather than a source of insecurity.

Variables

With focus on the existing differences in feelings of competence in science, prospective elementary school teachers may be seen as functioning on different levels with respect to science, as outlined in Maslow's theory of basic needs (Goble, 1970). If the theory is applicable even to a small sector of a teacher education program, persons insecure about their capabilities within that sector need a different type of program than those functioning on a higher need level with respect to the sector.

The variables of the study were chosen to apply as closely as possible to the Maslow theory. It was assumed that operational definitions could be provided in the form of scores on instruments based on the theory. The very special circumstances calling for a pragmatic approach prompted the inclusion of two other variables as well, presumed to be of practical interest.

Self-estimated Proficiency in Science (SEPS)

A factor hypothesized to be of decisive importance for finding a suitable type of methods course was self-estimated proficiency in (physical) science, a term used here to describe a person's view of his own capabilities within the disciplines of physics and chemistry as the person has experienced the subjects in school and in everyday life, but excluding all aspects of teaching physics or chemistry. The variable was considered the main independent attribute variable of the study, as it is conceptually very closely linked to the Maslow theory.

Students with low measured scores on their self-estimated proficiency in science were hypothesized to function on a low need level (need of security) with respect to science. However, it was expected that there might be students governed by social needs, needs of esteem, and needs of self-actualization with respect to science. Self-actualization in science is quite a reasonable idea according to Maslow (1971), but against the background sketched, it is probably not a very common state among presumptive elementary school teachers. However, any students functioning on higher need levels were hypothesized to be among those with high scores on their self-estimated proficiency in science. As there was no way to determine absolute levels, a cutoff point to separate the high scorers from the low scorers had to be defined.

Actual Proficiency in Science (APS)

The self-estimated proficiency in science is different from actual proficiency in (physical) science, as measured by achievement or process analysis, although a significant correlation would be expected (Doran & Sellers, 1978). The relationship is complicated by individually different reference levels — some students need high actual proficiency to feel competent while others get by with a low proficiency. The general academic proficiency, self-estimated and actual, is of importance in this connection, as are factors relating to the psychological background of the students. From this viewpoint, actual proficiency in science was seen as a main (possibly dominant) factor influencing the self-estimated proficiency in science, but not the only one. Although it does not fit directly in the Maslow theory, it is far easier to define operation-

ally, and for practical purposes it was seen as an alternative on which to base future instruction, even if one retained the Maslow theory as the starting point. Thus, in the study, measures of the self-estimated proficiency in science were supplemented by measures of the actual proficiency in science, and the latter information was used in a similar way as an independent variable.

Sex

Considerations analogous to those for APS apply with respect to sex as an independent variable. In the study sex was used as an alternative attribute variable to SEPS, but it was also controlled by examining the main hypotheses separately for female students. The decision to do so was based on the indication that the problems were more prominent for female students. A full analysis using a design with more than one independent attribute variable was not feasible because of the small number of students (and particularly male students) available for the study.

Types of Methods Course

The independent experimental variable was operationally defined by two types of methods course presumed to be suitable for students with extreme measures on their self-estimated proficiency in science.

A methods course aimed at students with low self-estimated proficiency in science tried to eliminate specific concerns that are commonly associated with teaching science. It involved an attempt to emphasize the basic competencies necessary to acceptable performance in the future for as many students as possible. In essence, it deviated rather little from the traditional way of giving methods instruction in physics and chemistry in Finland. In the following, it will mostly be referred to as the "traditional" course.

The methods course aimed at the high scorers concentrated on the personal meaning to be gained from teaching science, in self-esteem, recognition, and above all self-actualization. Its primary basis was the humanistic theory of education advocated by Combs and others (Combs, Aspy, Brown, Clute, &

Hicks, 1978). In the following, it will mostly be referred to as the "humanistic" course.

The methods courses are described and compared in more detail in Chapter III.

The Dependent Variable

The difference between teaching a subject and merely knowing it is emphasized in the choice of the dependent variable. Again following Maslow, the construct of interest is the level of functioning with respect to teaching physics and chemistry. However, when the methods course is over, actual teaching lies far ahead in the future, and any measures obtained at the end of the course must necessarily refer to an expected future situation, i.e., include an element of apprehension. Recongnizing this fact, and limiting the dependent variable to a measure of the expected future insecurity with respect to teaching physics and chemistry, a better term for it is anxiety specific to the teaching of (physical) science. Within the conceptualization of teacher anxiety given by Keavney and Sinclair (1978), the construct most closely corresponds to the A-trait category, or is concerned with threat recognition specific to the teaching of physics and chemistry. Absence of anxiety would then, according to Maslow's theory, imply expectations of future functioning on higher need levels.

Figure 1 depicts the hypothesized relationships between the variables considered. The independent attribute variables are antecedent to the experimental variable, the effect of which on the dependent variable is part direct, part interactive in nature.

Research Hypotheses

Although the design of the study included methods courses explicitly aimed at different sections of the population, both types of courses were given to all-inclusive groups of students. The hypotheses formulated thus express the relative efficacy of the courses for subjects with different measures on the independent attribute variables. Distinction was made between main

effects (1, 2) and interaction (3). In addition, a hypothesis concerning the predictive power of the construct self-estimated proficiency in science was formulated (4).

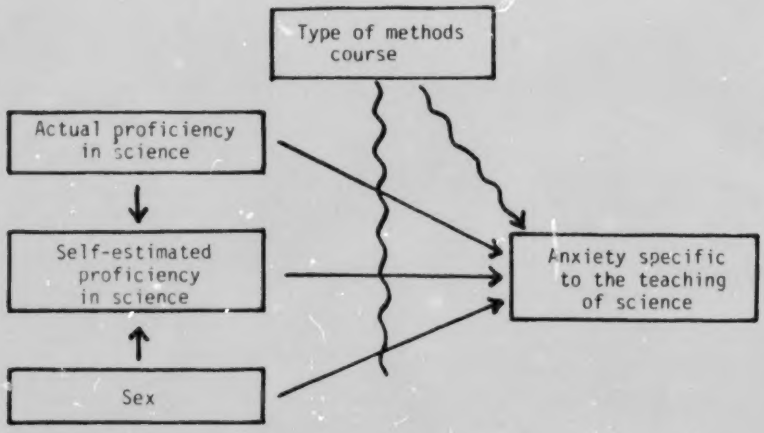
Type of methods course
Actual proficiency in science
Self-estimated proficiency in science
Sex
Anxiety specific to the teaching of science

Figure 1

The Variables of the Study

Main Hypotheses

H_1. Students with high scores on their self-estimated proficiency in science will show less anxiety specific to the teaching of science than students with low scores on their self-estimated proficiency in science.

H_2. There is a difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization.

H_3. There is interaction between the effects of the self-estimated proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

H_{1a}. Female students with high scores on their self-estimated proficiency in science will show less anxiety specific to the teaching of science than female students with low scores on their self-estimated proficiency in science.

H_{2a}. There is a difference in the degree of anxiety specific to the teaching of science between female students given a methods course emphasizing basic competencies and female students given a methods course aiming toward self-actualization.

H_{3a}. With respect to female students, there is interaction between the effects of the self-estimated proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

Side Hypotheses

H_{1b}. Male students will show less anxiety specific to the teaching of science than female students.

H_{2b}. This hypothesis constituted a repetition of hypothesis H_2.

H_{3b}. There is interaction between the effects of sex and the type of methods course given on the degree of anxiety specific to the teaching of science.

H_{1c}. Students with high scores on their actual proficiency in science will show less anxiety specific to the teaching of science than students with low scores on their actual proficiency in science.

H_{2c}. This hypothesis constituted a repetition of hypothesis H_2.

H_{3c}. There is interaction between the effects of the actual proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

H_4. The score on the self-estimated proficiency in science is a better predictor of anxiety specific to the teaching of science than sex or the score on the actual proficiency in science.

Assumptions and Limitations

The selection of variables reflects the specific circumstances under which the study was conducted. The conclusions were intended to be used for curriculum development at the Faculty of Education at Abo Akademi, Vasa, Finland, and this purpose was held important enough to reject a selection of experimental situations that would include other institutions of teacher education in Finland. The decision is particularly natural when one recognizes that the Faculty of Education at Vasa is exceptional in the sense that its students are trained to become teachers for the Swedish-speaking part of the population of Finland.

Keeping the study within one institution, it was possible to control variables such as instructor influence, language, resources, and interaction with other courses of the teacher education program. On the other hand, the small number of students in each yearly class of elementary education students made a total investigation of one class necessary to allow for a reasonable number of subjects (56). Statistical methods treating the population as a sample presuppose the possibility of regarding it as a sample in time or a sample from a set of teacher education institutions with similarities in their practices. To allow for such generalization, a telegraphic account of the studies at the Faculty of Education at Vasa is included as Appendix A.

It is not difficult to envisage other variables that might have been informative in the study, e.g., self-concept, general anxiety for teaching, and academic achievement, particularly academic achievement in physical science. However, in addition to difficulties incurred by treatment of more variables with the small number of available subjects, most of the conceivable variables lack specificity with respect to science and were thus considered less appropriate. As for achievement in science, a large portion of the students had no high school physical science at all, and going farther back in time to find commensurable measures was judged to be an error-prone procedure.

With regard to Maslow's theory of a need hierarchy, it is recognized that absolute need levels are extremely difficult to define. Still more difficult is the identification of individuals functioning on various levels. The practical solution was to use a somewhat arbitrary cutoff point between high and low scorers on the instrument measuring the self-estimated proficiency in science. The significance of that cutoff point is easy to challenge from the view-

point of the theory. It is rather a case of an operational definition and should be interpreted as such.

Another assumption central to the study, but having some support in literature (McClain, 1970, Smith, 1975), is the possibility of applying the Maslow theory to a single course within a teacher education program. The hypothesized difference in the effects of the two types of methods course on the anxiety specific to the teaching of science expresses that assumption in a testable form.

CHAPTER II

Review of related literature

This chapter gives an overview of literature relating to the problem stated in the previous chapter and literature that was found valuable in the search for a solution. The references are restricted to research published in the United States of America.

The first three sections concentrate on the concept of anxiety among preservice teachers, its connection with humanistic theories of education, and the special problems in the relationship between humanism and science. A fourth section deals with attitudes and science, and includes a review of instruments used in attitude research. The final section describes innovative methods courses that served as sources of inspiration in the development of the experimental courses.

The Anxieties of Preservice Teachers

The insecurity of prospective teachers has been the subject of considerable research, particularly feelings of anxiety with respect to student teaching. The nature of the anxieties was examined in the studies by Thompson (1963) and by Sorenson and Halpert (1968); later, these studies were much quoted in the literature. A comprehensive account of work published up to 1975 was included in a review article by Coates and Thoresen (1976), who also gave a detailed discussion of the concept of teacher anxiety.

Their distinction between two major uses of the term anxiety, sometimes roughly equivalent to concerns (sources of anxiety) and sometimes equivalent to anxious behavior, was criticized as insufficient and further developed by Keavney and Sinclair (1978). The latter conceptualize A-trait (disposition to be anxious) as a category for threat recognition that is stored in memory.

A-states (anxiety responses) occur when the specifications for threat are met by the stimulus situation. Such states are somatic responses, thoughts about inability to cope with threat, and coping styles that are overlearned patterns of responding, previously associated with threat reduction. Furthermore, the relationship between anxiety and correlates such as concerns, self-concept, etc. is not necessarily causal – and if it is, the correlates may be the consequences as well as the sources of anxiety.

However, with respect to prospective teachers, teaching anxiety is most easily seen as a composite construct which is operationally defined through situational concerns or categories of concerns which can be sampled in an appropriate way. This is a tacit assumption in several studies and the reason for the confusion in terminology.

The relationship between self-concept and success in student teaching was studied by Garvey (1970), who found that success in student teaching is affected, but not necessarily determined, by a positive view of oneself, lack of confusion in self-perception, and good adjustment. Jordan, Davis, and Schapiro (1977) analyzed different aspects of the self-perception of preservice teachers and found a significantly less positive response to "the way professors see me" than to other aspects of the self-perception. They interpreted this as an interpersonal chasm between faculty and students.

The changes in self-concept during student teaching were studied by Lantz (1964). Fuller, Pilgrim, and Freeland (1967) identified characteristic stages in the development of prospective teachers,

- Where Do I Stand?
- How Adequate Am I?
- Why Do They (the students) Do That?
- How Do You Think I'm Doing?
- How Are They (the students) Doing?
- Who Am I?

passing through roughly delimited concern categories which culminate in reflections on oneself in the teacher role. Fuller (1969) later conceptualized the concerns of teachers slightly differently, summarizing information from numerous investigations up to that point in time.

An explanation of the anxieties of student teachers based on Maslow's need hierarchy was given by Aspy (1969). According to Aspy, the majority of the students, at least in the beginning of their student teaching experience, are operating on the safety level – trying to survive in the classroom – while they are asked to be able to give of themselves. A general theory of clinical experiences in preservice teacher education, also based on Maslow's theory, was developed by Warner (1973), who advocated microteaching and simulations as valuable activities through which nonthreatening relationships between trainee and pupils can be developed, thus gratifying the needs for love and belongingness within the instructional role.

The Fulton Project (Gilroy & Moody, 1976), designed to reduce anxiety for student teaching and reporting substantial success, included features of a similar kind, gradual introduction to the teaching process, the opportunity to experiment in a no-fail situation, and the support of peers, cooperating teachers and college professors as the student progressed through the program. The relationship of the cooperating teachers and the professors to the prospective teacher is in the center of the theory of supervision in teacher education developed by Dussault (1970). It was derived from Carl R. Rogers' theory of therapy and personality change (1959, 1961) and thus drew parallels with the relationship of a psychiatrist to his client.

Humanistic Programs and Self-Actualization

Fuller, Pilgrim, and Freeland (1967) suggested "intensive individualization" as a key to mental health in teacher education. Their experimental program made provisions for the personal growth of the individual prospective teachers and for the teachers of the prospective teachers as well as the psychologists engaged as consultants. It involved detailed analysis of the stages of concerns for each prospective teacher and defined developmental tasks. The results showed that the experimental group advanced more along the scale of concerns than a control group.

In a similar vein, the Personalized Teacher Education Program, as implemented at the University of Northern Colorado (Copeland & Febinger, 1976), also used a concerns model, but with less assessment of the individual concerns.

Individualization very often is a main component of experimental teacher education programs, but unfortunately the term is attached to very different concepts. According to Jernstedt (1976), however, one may identify five common features in "individualized programs," (a) behavioral objectives, (b) a unit approach, (c) mastery as a criterion, (d) self-pacing, and (e) positive motivation. The term "individualization" is used here in this limited sense.

Humanistic programs may share features with individualized programs, but their emphasis on the learner is different and has been crystallized in the general definition given by Clute (1978):

Humanistic Education:

1. Accepts the learner's needs and purposes and develops experiences and programs around the unique potentials of the learner.
2. Facilitates self-actualization and strives to develop in all persons a sense of personal adequacy.
3. Fosters acquisition of basic skills necessary for living in a multi-cultured society, including academic, personal, interpersonal, communicative, and economic proficiency.
4. Personalizes educational decisions and practices. To this end it includes students in the processes of their own education via democratic involvement in all levels of implementation.
5. Recognizes the primacy of human feelings and utilizes personal values and perceptions as integral factors in educational processes.
6. Develops a learning climate which nurtures growth through learning environments perceived by all involved as challenging, understanding, supportive, exciting, and free from threat.
7. Develops in learners genuine concern and respect for the worth of others and skill in conflict resolution. (pp. 9-10)

Arthur W. Combs has been a leading proponent for the implementation of a humanistic philosophy in teacher education (Combs, 1965; 1972), and the experimental programs along these lines at the University of Florida are well known (Blume, 1971; Rowe, 1974). Research results there give indication that a humanistic program may produce teachers who are more flexible and self-confident (Busby, Combs, Blume, Avila, & Oberlin, 1974).

Combs sees teacher education as a process of becoming, and adopts Maslow's need hierarchy as a basic scheme applying to the process (Combs, 1972). The self is seen as an instrument (Busby et al., 1974), and since self-actualization is the highest-order need, it also is a goal for teacher education, even though the process of becoming naturally does not stop when the highest need level is reached.

Carl R. Rogers, although largely uninterested in traditional teaching (Rogers, 1969, p. 103), has expressed very similar thoughts both with respect to the self as an instrument and with respect to self-actualization. "Learning will be facilitated, it would seem, if the teacher is congruent. This involves the teacher's being the person he is, and being openly aware of the attitudes he holds" (Rogers, 1961, p. 287). "For significant learning, a teacher's basic reliance would be upon the self-actualization tendency in his students" (Rogers, 1961, p. 289).

Teacher training works the same way – "Such attitudes are 'caught' experimentally from another. They are not simply intellectual learnings" (Rogers, 1977, p. 627).

The concept of self-actualization has, of course, been studied in the closest detail by Maslow (1954, 1956, 1976), who gave long lists of the characteristics of self-actualizing people, later to be supplemented and interpreted by others. According to Maslow (1976, pp. 44-47), a person self-actualizes when

1. He experiences "fully, vividly, selflessly, with full concentration and total absorption."
2. In the presence of choices, he chooses movement toward growth rather than defense, safety, or fear.
3. He listens to "impulse voices" as a source for judgment, letting his own self rather than outside influence be the reference.
4. When in doubt, he chooses to be honest rather than not, and assumes responsibility for his actions.
5. By expressing his honest opinions, he accepts the risk of being unpopular.
6. He works arduously in order to do well the things he wants to do and strives to be first-rate or as good as he can be.
7. He experiences occasional, transient moments of joy or ecstasy, which Maslow refers to as "peak experiences."

8. In finding out who he is, what he likes, and what he does not like, he identifies his own defenses and finds the courage to give them up.

In a review of the concept (Combs, Avila, & Purkey, 1978, p. 85), three factors are described as especially characteristic of self-actualizing persons. They are a positive view of self, openness to experience, and identification with others.

Through the importance of a consistent "Weltanschauung," self-actualization is linked to science as well as to other disciplines. "Science *can* be a path to the greatest fulfillment and self-actualization of man. It *can* test his highest powers, bring him to his greatest heights, and bring out everything most admirable in him" (Maslow, 1971, p. 94). However, Maslow continues:

> But it can also serve as a retreat from life and from humanness.... This is why so many brilliant students drop out of science. They are asked to give up too much of their human nature, too many of the rewards of living, and even some of the values that led them to think of science in the first place. (Maslow, 1971, p. 94)

This may occur when the specialist loses his reference in everyday life, e.g., when the ecstasy of self-actualization turns into cold technology.

Similarly, excessive adherence to one ideology in education may lose sight of reality. As for humanistic education, Rogers realizes what a threat it may constitute to traditional educational and raises the question: "How can we make sure that there is always a place for both students and faculty who desire a traditional education? We don't want to coerce people into freedom" (Rogers, 1977, p. 625).

Putting it in Maslow's terms, safety will mean different things to different people. Also, for the same person in his different roles in life, safety will have quite different aspects. In his discussion of problems relating to the integration of self and role in teacher education, Weinberg (1972) states:

> ... we should not only concern ourselves with problems of enabling persons to relate interpersonally in a way that is both difficult and unclear in the institution, but also we should focus upon ways of shifting the informal structural components to insure a reduction of self-role conflict extrinsic to the self. (p. 83)

To the prospective teacher the future role itself may be a source of anxiety, and, in particular, the incidental role of a science teacher may be a factor evoking a defense mechanism. In preservice training this means reduced accessibility. The idea of matching the training program to the skill level and the accessibility characteristics of the trainee is central to the kind of individualized teacher education advocated by Hunt (1972). In the present work, the hypothesized interaction between the effects of the selfestimated proficiency in science and the type of methods course suggests a need for matching in the sense of Hunt.

Science vs. Humanism in Education

The historical evolution and the present status of the Two Cultures controversy have been reviewed by Green (1979) and Bieniek (1981). Although an oversimplification, it is generally seen as a worthwhile starting point for discussion of the relationship between science and the humanities. To be more precise, the existence of a controversy – as exemplified in differences in objectives and values – should not be exaggerated to the point where one does not see the similarities (McCain & Segal, 1977, p. 167).

The relevance of the controversy in education, and the impact of education on the gulf between the cultures, is paramount.

> It is unlikely that our society will forego the benefits it has acquired through expertise in power knowledge; consequently, the dominance of the scientific culture in education will not change. Yet ... it is important from a humanistic standpoint to challenge the confident belief that we can improve the human condition through the application of power knowledge. (Bieniek, 1981, p. 422)

A corresponding adjustment of education in the humanities is visualized as a necessary complement. On the other hand, to many science educators it seems that the striving for new views has gone too far:

> The science teacher these days will hear appeals to "humanize" his courses. The beautiful structure of the sciences might soon be disrupted by "informal, relevant science." Respect for the facts will become passé. (Troost, 1973, p. 209)

The interrelatedness of science and humanism and its strong implications for science teacher education have been stressed by Ost (1973). Ost argues in favor of a treatment of science which deemphasizes it as consisting of separate disciplines and at the same time observes the human qualities of choice, self-evaluation, and self-realization. He also sees the Maslow theory of basic needs as applicable to the career of science teachers. When changes in society occur, a self-actualizing interpreter of science will have the "plasticity to accommodate to change. He will be able to identify his weaknesses and instigate corrective measure. . . . His understanding of the nature of science in the newly evolved society will be meaningful" (Ost, 1973, p. 523).

Attitudes and Science

In view of the differences of opinion, the suggestion of using humanistic methods in science may always be controversial. However, much interest has been shown in the attitudes toward science, which shows the concern science educators have had for the appreciation of their subject. Studies in the United States (Blackwood, 1964; Washton, 1971) have revealed a situation similar to that in Finland, and the experimental programs, humanistic or not, must be seen against that background.

The definition of "attitude toward science" will vary with the researcher, and mostly the instruments that have been used were made for a particular purpose. A distinction must be made between instruments measuring "attitude toward science" and those measuring "scientific attitude." The latter kind will usually postulate certain qualities such as rationality, curiosity, etc., as characteristic components and attempt to measure the degree to which they are present in a person (Billeh & Zakhariades, 1975). A third kind of instrument will measure the respondent's knowledge of the nature of science (Billeh & Malik, 1977; Kimball, 1967; Rubba & Andersen, 1978; Welch, no date; Woodburn, 1974). Unfortunately, a particular instrument need not belong to just one of the above categories, e.g., there may be items testing the knowledge of the nature of science contaminating an instrument which mainly concerns attitude toward science but has the dual heading "What Is Your Attitude Toward Science? (A Scientific Attitude Inventory)" (Moore & Sutman, 1970).

The distinction between "attitudes toward science" and "attitudes toward teaching science" has been observed more clearly. Butzow and Davis (1975) developed a semantic differential to test inservice teachers' attitudes toward teaching elementary science. The Science Teaching Opinion Survey (Golmon, 1975) is an opinionnaire concerning preferred principles of teaching science among preservice science teachers. Other instruments include both attitude toward science and attitude toward teaching science, but within different subscales (Moore, 1973; Moore & Sutman, 1970; Redford, 1974). However, none of the instruments mentioned were expressly designed to measure the insecurity or anxiety felt toward science or teaching science. Actually, a measure of self-concept in science like the one developed by Doran and Sellers (1978) to study its relationships to gender, mental ability, and science achievement among high school students comes much closer to those used in the present work. However, its starting point is the activity in the science classroom in school, which limits its usefulness in other connections. Doran and Sellers found significant correlations between all the variables except gender. Gender correlated with mental ability only, indicating that male students had a higher mental ability than female students.

A somewhat related study, but directed toward preservice elementary teachers, was conducted by Shrigley (1974b) to test the correlation of science attitude and science knowledge. The instrument (the Science Attitude Scale for Preservice Elementary Teachers) used to measure attitude was the same one Shrigley (1974a) had used to study the effects of sex differences, male elementary teachers, organized vs. incidental elementary science programs, and the number of high school science courses on the science attitude of preservice teachers. Shrigley's results indicated a low positive correlation between science knowledge and attitude. Sex differences and experiences of male teachers in elementary school did not show significant correlation with attitude toward science. Experience of an organized elementary school science program and the number of high school science courses both correlated positively with attitude.

Shrigley's results are partly in disagreement with other results, as Washton (1971) found a stronger relationship between science knowledge and attitude, and Taiwo (1980), in a Nigerian study, although agreeing with the relationship between previous exposure to science education and attitude toward science, found the relationship between gender and attitude toward science to

be even stronger. In a study directed toward inservice elementary teachers, Shrigley and Johnson (1974) did obtain results showing a sex bias.

Earl and Winkeljohn (1977) tested another result by Shrigley and Johnson (1974), who had found no difference in attitude toward science between inservice teachers teaching in a self-contained classroom and those working in a cooperative setting. They again identified attitude toward teaching science as a variable that might have been missed and chose to use the instrument by Moore (1973). The results supported those of Shrigley and Johnson with respect to attitudes toward science. In attitudes toward teaching science, however, there was a significant difference indicating teachers in cooperative settings to show less negative attitudes than teachers in self-contained classrooms. Earl and Winkeljohn assumed the assignments in a cooperative setting to be such that those teaching science were "science specialists" and interpreted the results to mean that teachers who have become "science specialists" have done so not because of more positive attitudes toward science but due to more positive attitudes toward the teaching of science.

Innovative Methods Courses

A prime aspect of a methods course in education is the relevance of the instruction and the skills obtained to professional activity in a not easily foreseeable future. Partly the methods courses are active agents of change, but more often they have been seen as periods of adaptation to the educational environments most likely to be present in the future. This is even more true for clinical experiences. Where diverse possiblities are visualized, the program has to be geared accordingly.

> Basically, to achieve the competent curriculum-proof teacher, teacher training pograms should present the teacher with as many alternatives as possible and simultaneously encourage him to create additional ones. Thus, a pool of various possibilities would be developed from which the prospective teacher would select his own way for the science and technology education of his students. (Zoller & Watson, 1974, p. 101)

The multitude of innovative methods courses presented in the literature usually have this aspect of plurality in common. The example set by the instructor is not seldom emphasized:

> An effective methods course needs to be taught with a variety of methods so students can see in action what they are supposed to be learning. A university professor espousing individualized instruction in a methods course conducted with a traditional lecture-textbook approach is less than reassuring. (Leake, 1976, p. 193)

In other aspects, the philosophies or strategies employed vary along a very wide spectrum. An attempt at classification would need several dimensions of description and would be likely to do injustice to the innovations. Partly this is due to variations in terminology, but an important reason is the impossibility of giving a complete account in a paper of a course that may last for a semester or longer. The degree of difficulty of description also varies with the type of the course, being easier for courses with specific activities and mastery criteria of evaluation than for courses relying on the interaction between the instructor and the prospective teachers, to give an example.

A line of reasoning focusing on the future teacher role and the reality of the school environment argues for a close acquaintance with the experiences of active teachers in their first year (or first few years) of work. Collea (1974) investigated the "reality gap" between expectations and college preparation of secondary school science teachers and their first teaching role. He found enough discrepancies to introduce the term "reality shock" and devised a model which included an affective thrust to be begun during the college years and continued in the inservice phase. Like Troxel (1971), he also argued for science content and science methods in close connection, to "unsophisticate" the material.

At the elementary level, Gabel, Rubba, and Franz (1977) investigated the effect of increased emphasis on the science process skills in the laboratory section of the physics course on physics achievement, on proficiency in the science process skills, and on attitude toward science and science teaching. Another independent variable was early observation and teaching experiences in local elementary classrooms. Results showed that increased emphasis on science process skills had a significantly beneficial effect on physics achievement and on proficiency in the science process skills, whereas early observation and teaching experiences had a significantly beneficial effect on physics achievement. The effects on attitude toward science and science teaching, as measured using the Moore (Moore, 1973; Moore & Sutman, 1970) instrument were not significant. An author-constructed instrument, however, showed the

observation-teaching experiences to have a significantly positive effect on attitudes. The authors claimed their results to show that science process skills can be taught within the framework of science content, thus freeing the methods courses to focus on teaching techniques.

Sherwood and Gabel (1980) described a course, given at Indiana University, designed to give students the basic skills necessary for successful performance in subsequent science courses, to show them the materials and methods that are used in teaching elementary science by using these materials and methods in the course, and to give students a positive attitude toward science and science teaching. The basic skills referred to science process skills as agreed on by representatives of the science and science education departments. Part of the emphasis was on mathematical techniques. As expected, there was a significant gain in science process skills, but it was disappointingly small. There were no significant improvements in attitudes toward science and science teaching as measured using the Moore instrument. The best predictor of course success was found to be a Fraction and Decimal mathematics test.

Markle and Capie (1975) presented a rather similar competency-based physics program for elementary teachers at the University of Georgia, with heavy emphasis on basic process skills and activities from existing elementary science programs. The course was arranged in modules with previously set criterion levels for passing performance as well as for the various letter grades. Self-pacing was an additional feature.

At the secondary level, a science methods course "by learning contract" (Heimler & Cunningham, 1972) went further in individualization. Each learning activity was assigned a specific number of credit points toward a contracted sum, as agreed upon by the student and the instructor. An example of a methods course in education (Williamson, 1977) describes still another variation. Before beginning a unit, students were given an opportunity to take a pretest on it. If they passed, they were given credit for the unit. Otherwise, they would normally complete a few of the unit activities and then take the unit examination.

Volker (1970) outlined a competencies approach to teacher education in which individualized instruction is practiced, in which the student is made aware of those competencies that are expected of him, and in which he is given the opportunity to develop the competencies in real school situations. The features of the program were the following:

1. Independent study questions, intended to focus group discussions or to be examined in depth by individuals.
2. Instructional packages integrating the theoretical aspects of the teaching process and practice.
3. An open activities laboratory, providing the opportunity to practice basic instructional techniques and helping develop a philosophy of science teaching.
4. Peer-group teaching.
5. Increased school involvement, both prior to and concurrent with methods instruction as well as in student teaching.

If the goal of a methods course is to obtain basic competencies in teaching science, and if one assumes that a teacher should have had experiences of the kind pupils are expected to have, a logical philosophy for a methods course may demand an inquiry approach in at least part of the course. However, those are not the only assumptions that may lead to a similar conclusion. Jones and Harty (1978) contrast "inquiry" methods with "traditional" methods and relate the methods used to one of two classroom management styles:

> A teacher expressing a high preference for "inquiry" instructional approaches might also reflect a strong tendency for "humanistic" classroom management strategies; or vice versa, a strong preference for "traditional" teaching methods might relate to high orientation toward "custodial" classroom management preferences." (p. 1)

In this view, a "humanistic" orientation refers to student learning through cooperative interaction and experiences along with substituting self-discipline for strict teacher control.

An inquiry approach in a methods course appears to be quite reconcilable with a wide variety of other approaches in the same course. In a course described by Bicak (1975), however, investigation formed the content of the course, and inquiry thus was the fundamental constituent. The implementation included three elements:

1. Identification of problems and designing investigations (experiments or observations) based on the problems.

2. Examination of existing investigations from the past and the present. Selection of a good or a poor investigation, taking a position relative to it, and defending it.
3. Representative curricular activities. Learning from investigations in existing curricula by carrying them out.

In integrated science programs, where science and science education departments cooperate (Nordland & DeVito, 1974; Sherwood & Gabel, 1980) inquiry methods lend themselves naturally to the sequence (a) science content presented as inquiry, (b) methods of teaching applied by the instructors, and (c) translation of inquiry science teaching techniques to situations with children. In the collaboration at the University of Washington reported by Arons and Smith (1974), the transfer is made explicit:

> For each unit, parallels are drawn between the problems the preservice teacher has in manipulating the equipment and developing a particular concept and the problems faced by the elementary age child whom he or she will be expected to teach. (Arons & Smith, 1974, p. 397)

In his "Position Statement Regarding Elementary Science Methods Courses," McCormack (1972) sees the inquiry mode as a means for the development of positive attitudes toward science, science teaching, and an activity-oriented approach to science learning – the "primary aim" of a methods course. With the same goal in mind, after completing the course the student should feel as if he had reached a higher mastery level of at least some elementary science concept. This clearly addresses the self-esteem needs of the Maslow theory. The humanistic philosophy of the position statement shines through in other "guidelines," too, e.g., the course should develop confidence on the part of the student in designing his own individual teaching-learning activities, devices, lessons, and units.

The science preparation within the "New Elementary Program" at the University of Florida, as described by Blume (1971) and Rowe (1974), is entirely humanistic in its basic philosophy. At the heart of the program is a seminar where the student develops a close relationship with a faculty member, becomes a member of a small group of students, and discovers the personal meaning of his experiences. The advisor also guides the field experiences which continue through the program.

Science content and methods come in as one of the academic areas represented in the "substantive panel." A faculty member distributes lists of competencies for students to complete and hand in or to discuss in faculty-student conferences. The competencies lists are partially individualized, containing both required and optional elements. Many call for the student to perform the activity in conjunction with children. The latitude for choice is considerable, giving the student part responsibility for his own program, and even encourages him to suggest activities of his own design.

The science portion of the program is criterion referenced. A student works on an activity until satisfactory achievement is reached. In the seminar, the time schedule is set on a contractual basis, and progress is reported to the advisor.

A study reported by Oberlin and Sanders (1973) compared the science content knowledge of graduates from the New Elementary Program with that of graduates who had their science education in a traditional course. There was no significant difference and, as a whole, the content knowledge was disappointingly low. As a result, a requirement was added that to complete the science area each student must score at or above the 75th percentile for end-of-the-year ninth grade students on a standardized general science content test.

Although not a methods course in science, a course of interest with respect to humanistic philosophy based on the Maslow theory will be mentioned here. McClain (1970), noting the need for such a course in teacher education, investigated the effects of a mental health course specifically aiming for self-actualization. Nearly all the class time was devoted to administration of a battery of personality instruments and discussion of the meanings of the results, thus emphasizing self-knowledge.

Among the instruments was the Personal Orientation Inventory (Shostrom, 1966), which is explicitly based on Maslow's concept of self-actualization. McClain obtained highly consistent results showing that the experiences of the mental health course helped the students make progress toward self-fulfillment.

A study by Smith (1975) corroborates the finding that a single course may have vast influence on self-actualization. Using the Personal Orientation Inventory, significant shifts toward self-actualization were found in preservice teachers after small group simulation experiences which entailed personal inquiry, planning, performance, analysis of teaching, and self-evaluation.

Not very many studies have dealt with the concerns of prospective teachers with respect to teaching elementary science. Oshima (1966) compared the effects of two teaching methods, lecture-demonstration and individual investigation. Results indicated that greater confidence is obtained by students performing their own investigations. Campbell and Martinez-Perez (1977) examined self-concept and attitudes as factors in the process-skills achievement of preservice teachers. Self-concept was measured using the Tennessee Self-Concept Scale (Fitts, 1965) and attitude toward science using the Scientific Attitude Inventory (Moore & Sutman, 1970). Although highly significant correlations between all the variables were obtained, it was found that self-concept was the only predictor of achievement. The researchers recommended that one should train teachers by involving them in activities that will allow them to become competent and to develop a strong "self."

Following Fuller (1969), Roberts, Chiappetta, and Jones (1974) outlined an elementary science methods course designed to help preservice teachers move toward concerns about their impact on pupils from having concerns about "self" and "teaching tasks," which were seen as lower levels in Fuller's conceptualization. The instructors served as teacher models to help the students get a feeling for the role of the teacher in teaching science. In that way an instructor's main concern is his pupil, the prospective teacher.

In relating their first experiences with the course, the authors stressed the uniqueness of science methods within an elementary teacher education program:

> Methods students not only have concerns about teaching science; in all too many cases, they also have very deep concerns about learning science. They enter science methods with a minimum background in the sciences. The science courses which they have completed usually have emphasized the content of science and have convinced many that they cannot deal effectively with science. It is not surprising then that these students have real concerns about the task of learning how to teach science. (Roberts, Chiappetta, & Jones, 1974, p. 382)

With regard to self-perceptions in science, typical research will concern high school (Doran & Sellers, 1978) or elementary school (Shymansky, Matthews, Good, Penick, Kolebas, & Allen, 1974) students. "Humanistic" methods have been used in high school science (Robinson, 1980). The results,

as compared with normal courses, showed that a "Human Sciences" course was able to produce positive attitudes, especially for girls, at the end of a three-year test period. At the college level, a study by Dillon and James (1977) to determine the attitude of black college students toward science included a subscale "Self-Estimates of Proficiency in Science." It showed significant positive correlation with the number of high school science courses completed, the attitude toward science and society, attitudes regarding science and blacks, and attitudes toward science as a career, as measured using scales constructed by the authors.

A Reflection

The preoccupation with attitudes toward science, as evidenced in this review of literature, has left relatively little knowledge about the underlying components of the attitude. In this study it has been assumed that a description in terms of Maslow's need hierarchy is possible and that an attempt at improving conditions may start there.

The search for directly applicable instruments was not successful, however – those specifically based on Maslow's theory (e.g., the Personal Orientation Inventory) are too general to use in connection with the variables chosen. A conclusion arrived at agreed with the final statement in a study that examined the effects of science methods courses with and without field experiences on attitudes of preservice elementary teachers:

> An inventory to measure confidence about teaching science should be developed. The benefit of early field experience may be that of increasing one's attitude toward science. If one's confidence about teaching science is increased, then the individual may be more likely to teach science in the elementary classroom in a positive manner. (Weaver, Hounshell, & Coble, 1979, p. 663)

CHAPTER III

Methods and procedures

This chapter begins with a description of the two methods courses that constituted the experimental variable of the study, and then proceeds to a description of the steps that were taken in order to test the hypotheses.

Arthur Combs (1979) has characterized the search for right methods in education as an exercise in futility. Teacher training institutions have had to rely on the experiences and the hunches of their faculties to determine what methods they will perpetuate, and still the answer will be hidden – because methods must fit the teacher and the conditions, and they are judged through the eyes of the pupils of the future. There is also a crucial difference between methods as practiced by the teacher educator and methods as adopted by the prospective teachers.

> There is a common belief in teacher education that students should always be exposed to only the very best models, but if this is carried so far as to create a feeling of inadequacy in the student, its net effect may be destructive. (Combs, 1972, p. 287)

A methods course that fails in this respect is not properly oriented in accordance with the Maslow theory. Both types of methods course in this study presupposed an environment of security – starting from acceptance of the students as they were and following a "maximum diet of success and a minimum diet of failure" (Combs, 1972, p. 287).

The situation with regard to evaluation of performance was particularly helpful. The grade given in the methods course in physics and chemistry was to be combined with grades given in the corresponding courses dealing with social life and biology into a grade for "environmental studies." A low grade would then possibly be compensated by a high one in one of the other

courses, and it consequently was possible to minimize the emphasis on the final exam.

The courses started out with an assurance that the final exam would be easy to pass – statistics from previous classes helped the message come through – and the promise was followed up when the exam was given.

The two types of methods course were run in parallel for 14 weeks during the spring of 1981. Each student belonged to one of four groups, two of which were given the humanistic course, and the other two the traditional course. The groups met for three consecutive hours each week. One group of each kind was scheduled as a morning course, and the remaining two were afternoon courses. Thus, the effect of scheduling was balanced as far as possible. The last meeting of each group was shortened by one hour – the amount of time allotted for the final exam, which was given in a later session with the four groups combined.

The Humanistic Course

In the humanistic course, the emphasis was on developing elements within the prospective teacher rather than to try to reconstruct identical situations between preservice and actual teaching experiences (Collea & Pagni, 1973). The humanistic theories of education were put into a science setting in accordance with principles developed by McCormack (1973):

1. To teach science humanistically, the teacher must first examine his own beliefs and attitudes toward science and teaching. He should be committed to ongoing reassessment of these beliefs.
2. Learning conditions should be structured so students can perceive and choose alternative pathways seen as leading to development of personal potential. People learn more efficiently if they make decisions about their own learning.
3. Learning involves at least two processes: acquiring new knowledge and determining personal meaning of the knowledge. Information not having personal meaning is not really "learned."
4. No one specific competency or item of knowledge is essential for effective teaching.

5. Science teaching should involve more than just the promotion of cognition. Values and attitudes should be dealt with openly.
6. Humanistic teaching requires the teacher to believe that concepts of self are as vital as concepts of science.
7. Teachers tend to teach the way they are taught, not the way they are told to teach.
8. Humanistic teaching is facilitated when student self-evaluation is adopted as a basic judgmental procedure and evaluation by others is regarded as of secondary importance. (p. 60)

Item 4 marks one point of difference between the two types of course very clearly, the traditional course presupposing the opposite.

Self-evaluation (item 8) cannot be prescribed in a uniform manner – as a general principle it was assumed that the almost complete absence of outside evaluation would stimulate self-evaluation. A concrete application of the principle was the indeterminate duration of most of the activities. For another thing, when an activity required a student to assemble science equipment from everyday objects, there were essentially no criteria of quality.

However, some activities were designed with self-actualization specifically in mind. In those cases a check on self-evaluation was made in the form of a required report on the personal meaning of the performed activity. The report could be delivered orally or in writing. Each student was required to hand in two written reports but could choose freely which activities to write about.

Personal meaning, also referred to in item 3, was translated into behavioral terms using evidence suggested by Griffin (1977):

Level One: What We Did. The student at this level speaks impersonally about the learning situation, i.e., the class is described in terms of its assignments of activities.

Level Two: What I Did. The involvement of the student is made explicit but the comments do not define his reactions to the activities.

Level Three. Brief Reactions. The student makes unelaborated self-references which present some aspects of his inner perspective. The self-references are tied to the learning situation, but not to the student's life in general.

Level Four. Meaning Exploration. The self-references go beyond the class situation and make clear the significance of the learning situation in relation to goals and self-concept. The implications for future activities are explored.

Level Three was considered as a reasonable requirement for reports on course activities, although the use of Level Four was encouraged.

The course employed two features suggested by McCormack (1973), an Objectives Bank and a Project Idea Bank, to pinpoint the personal goals of each student with respect to teaching physical science and to direct the student to activities geared to the goals. The method may be described as guided self-direction, i.e., offering of enough choices to have at least some that give a reasonable match with the way the students perceive their situation. It refers directly to item 2 on the list on page 45.

The Objectives Bank (the name was never explicitly introduced in Swedish) was realized in the form of a set of 36 cards with the wording "I want to ..." followed by an objective and one or more suggestions how to proceed. Some examples follow:

... form concepts and relations in the same way as pupils are expected to. Analyze water solutions of various substances.

... feel I develop my own self by participating in the class work.

1. Analyze your self-concept by working through a Swedish version of the Tennessee Self Concept Scale using a microcomputer.
2. On the basis of your results, take note of such things as you would want to develop. If they concern yourself in the teacher role, this course may be relevant.
3. Evaluate the activity with the instructor.

... learn to think like a scientist.

1. Refer to lecture notes or other sources for a description of science processes.
2. Choose a problem or a situation that you want to analyze. If you have no suggestion of your own, you will be given a problem. Do your work systematically.
3. Note where things broke down, e.g. through carelessness or changed conditions during the course of the work.

... learn explanations of common natural phenomena. Suggestions: the color of the sky, the rainbow, lightning, mirages.

. . . learn to distinguish between facts and opinions.

1. Choose a subject area surrounded by myths and/or poor understanding. Examples: climate and prediction of weather, nuclear energy, solar energy.
2. Make up a list of common opinions (both for and against, if applicable).
3. Try to find facts behind these opinions. Use available literature and write down your results.

. . . analyze my own opinions regarding the teaching of physics and chemistry within environmental studies.

1. Use STOS – a microcomputer program that can be run without previous experience of computers.
2. Evaluate your results and discuss them with the instructor.

. . . contribute with presentations that are useful to the other members of the group.

1. Go through the principles for demonstrations.
2. Prepare a short review of some demonstration experiments that you consider basic to a certain topic area at a certain grade level. If you have no clear preferences the instructor will advise you.

. . . learn to understand my own view of lifeless nature.

1. Choose a topic, as unclear to you as possible, among those taught at the elementary level.
2. Look up the corresponding pages in a textbook and find out if you learn more than you knew before.
3. Supplement with textbooks from higher levels or encyclopedias.
4. By comparison, try to find out if your former view came short of understanding a) facts, b) relationships, c) the importance to man, or whether you d) had not formed a view previously, or e) had accepted previous teaching passively.

. . . train my accuracy.

Carry through the testing of a hypothesis by experiment. Choose a situation where one variable depends on another or several others.

Don't forget to formulate the hypothesis. Examples: Ohm's law, Archimedes' law.

. . . discover how I function when I teach physics and chemistry.

1. You will be given two topics. Read what the textbook says about both. In addition, increase your knowledge about one of the topics.
2. Give a 5-10 minute presentation to your peers about each topic. Do not show which topic you know less about, but pretend you know equally much about both.
3. Let the others guess what topic you simulate knowing.
4. Afterwards, describe the difference in feeling when you taught.

In the majority of the activities the students were referred to the Project Idea Bank, which consisted of more than 700 laboratory experiments and demonstrations, inquiry projects, and factual information. The students had access to reference literature, an unstructured collection of everyday objects and materials, and laboratory equipment designed for elementary science education. As the premises were in use by prospective teachers of secondary science as well, there was also available more advanced equipment, which could be used whenever an activity aimed at more deep-going understanding of a certain topic. Generally, however, the projects required only very simple things to work with. In some cases the chosen activities demanded the use of things that had to be borrowed from the cafeteria, the music department, or improvised in some other manner.

The Project Idea Bank was organized in a way that made it suitable for different use in the traditional course, whereas the Objectives Bank was specially designed for the humanistic course.

Another feature derived from the list on page 45 (items 1 and 5) was the use of attitude inventories on a microcomputer. They applied to activities which aimed at knowledge of self; and with the computer instant feedback was possible. The following inventories were thus used as course material, but the results were not used in the study itself:

The Tennessee Self Concept Scale (Fitts, 1965)
The Minnesota Teacher Attitude Inventory (Cook, Leeds, & Callis, 1951)
The Science Teaching Opinion Survey (Golmon, 1975).
Each student took at least one inventory.

Although the objectives were individually chosen, in many cases it was possible for two or even three students to cooperate in an activity. This was a consequence of the fact that each student chose several objectives in the beginning of the course and that some objectives proved more popular than others. Each student participated in at least one group work (four or five students). However, the reports were always individual.

Usually an activity would be completed during one session, but there were a few that lasted for two or even three sessions.

Demonstrations: While the students went through individual programs of activities, there was still the possibility of sharing experiences through demonstration of procedures and results to the peers. These attempts at teaching in a safe environment were for many students some of the first performances in the teacher role. In the analysis of the demonstrations, the starting point was the student's own reactions rather than the effect of a similar demonstration to elementary school children.

Lectures: The course included a few lectures of less than an hour each. They were specifically designed to tie the course activities to the humanistic theories of education (Combs, Maslow, Rogers). In one of the first lectures, the need hierarchy of Maslow was presented in a science setting – describing the growth and personal satisfaction that can be experienced through the teaching of science. In later lectures the components of a scientific attitude were analyzed in accordance with Diederich (1969), and humanism was tied to the natural sciences through an analysis of the relationship between an observer and his perceptions. The uniqueness of each individual and his view of the world was seen as a link to self-esteem, autonomy, and finally self-actualization. During one of the last meetings some advice was given for future development toward independence, creativity, and self-sufficiency as a teacher of physics and chemistry.

In addition, there were handouts dealing with lesson planning, questioning techniques, safety measures, and other topics in common with the traditional course. The final examination was based on the handouts only.

The Traditional Course

A principle for methods courses formulated by Kirby (1977) – "root growth before leaf growth" – is really applied horticulture and likens the

prospective teacher to a delicate plant. A stable superstructure requires a reliable base; this is the principle of any hierarchical system like the Maslow theory of basic needs.

The methods course aiming at students with low self-estimated proficiency in science was based on a philosophy that certain basic competencies are necessary if you intend to teach the subjects of physics and chemistry. If you are aware of too many wants, a superstructure with higher goals is meaningless.

This does not mean that the course was restricted to so-called "survival skills," the essentials of a few carefully chosen situations. Such an approach has been described by Hurd (1973) as "a kiss of death rather than survival." Interactions in a classroom are never twice the same; the basic competencies must include the aspect of change.

Instead, the basic competencies were postulated with the help of three kinds of sources:

1. Needs or importance assessments by active teachers of elementary and secondary science and science supervisors (Moore, 1977, 1978; Chiappetta & Collette, 1978). The assessments were selected on the basis of evidence of reliability and a wide range of applicability.
2. The new curriculum for environmental studies (*Omgivningslära. Lärokurs och läroplansanvisningar*, 1979), textbooks based on it, and teacher guides.
3. The inherent structure of the topic areas: the properties of matter, the conditions for human life, sound and light, magnetism and electricity, work, the sun and the earth.

The needs and importance assessments directed the emphasis to the following basic competencies:

- basic science reasoning skills,
- using the inquiry and process approach in teaching,
- planning appropriate instruction,
- keeping the pupils' interest,
- understanding the behavior of children in science,
- maintaining control in the classroom,

- providing for individual differences,
- obtaining and utilizing science materials.

Some common elements of methods courses were notably absent: behavioral objectives, methods of evaluation, and the use of audiovisual equipment. They were not highly rated in the assessments, and as they were well covered in other courses, the lack was not thought to be serious.

The division of science content into topic areas was the one recommended in the national curriculum. The topic areas have a certain similarity with the conceptual schemes used in American commercial programs like Concepts in Science (1975) and the Conceptually Oriented Program in Elementary Science (COPES, 1972) – they are treated at each of the elementary grade levels and allow for adoption of concepts at various levels of sophistication. The Finnish curriculum, however, has less of an interdisciplinary approach to science than the American ones, and even within physics and chemistry the topic areas resemble the traditional subdivision into mechanics, electricity, etc.

Each topic area may be further subdivided into topics, and the curriculum guide suggests a way to do it. This analysis was carefully performed in the course. The idea was to give the prospective teachers a reference frame for science content – for their own understanding and for the planning of instruction. Since part of the activities took up technical applications and social contexts, the reference frame could also be of use outside the classroom environment.

The Project Idea Bank was organized according to the topic areas, which provided for easy access. However, the students were usually directed to specific activities. A normal procedure was to turn the attention to a certain topic and to hand a group of two or three students some cards describing appropriate activities. Care was taken to vary the topics for each student as much as possible. Group work and group dynamics were studied with problems of the "Moonlander" type (Hall, 1969). Lesson planning utilizing a variety of approaches and provision for individual pupils came into increasing use toward the end of the course.

Each student was required to hand in two written reports of performed activities. This requirement was formally identical in both courses, but in the traditional course reporting personal meaning was not encouraged.

Demonstrations: In most cases an activity included the demonstration of one or more experiments or an oral description of an activity and its results to the peers. The emphasis was always on the classroom situation rather than the personal experience or the growth of the prospective teacher.

As the demonstrations were judged to have great influence on the (in-) security of the performer, demonstrations that were likely not to work out well were avoided. When a failure did occur, time was taken to analyze why, in order to help the student remember the situation as a learning experience rather than a personal failure.

Use of microcomputer: The possibility of a Hawthorne effect (Bracht & Glass, 1968) was estimated to be fairly small, as most concurrent courses were at least partly new because of the reform of examina and as the students were in their first year of studies. However, some of the features of the humanistic course were thought to amplify the impression of an experiment. The microcomputer was therefore brought into the traditional course as well, to counteract that effect, but its use was only superficially similar.

All the students of the traditional course took the same interactive computer program. Written by the researcher, it was a program aiming for mastery of a selection of basic facts from physics and chemistry, as needed in elementary school teaching.

Lectures: The proportion of lectures and the length of the lectures were approximately the same in both courses, although the topics were quite different. In the traditional course most of the material had been used in the same way in previous years. Major topics were the nature and history of science, Piaget's theory of the scientific development of children, science processes, an science equipment. Techniques for demonstrations and experiments were taken up in a systematic manner. Handouts common for both courses were discussed in more detail in the traditional course.

Three of the lectures were exclusively devoted to science content. The topics chosen – electricity, light, and sound – were selected because some of the concepts, as used at the secondary level, seem to be major difficulties and likely sources of insecurity. It was shown that a relatively small number of concepts are quite sufficient at the elementary level.

Design of the Study

The study employed a posttest only control group design as the basis for the statistical analyses of the results. This design is effective in controlling for threats to the internal validity of an experiment (Campbell & Stanley, 1966, p. 25). The design does not need an actual control group, as long as there are at least two groups to be compared. Either level of the experimental independent variable (type of methods course) may be considered the control.

Measurements of the main independent attribute variable, self-estimated proficiency in science, and its alternative, actual proficiency in science, were performed as pretests. It was recognized that the tests constituted threats to the external validity of the study in the form of pretest sensitization. The tests were therefore presented as tests to provide the instructor with background information for course arrangements rather than tests for research purposes.

The design did not include measurement of the dependent variable, anxiety specific to the teaching of science, as a pretest. Statistical equality between group means was obtained through random assignment of individuals to groups before the methods courses were given. The alternative of measuring the change in the dependent variable for each individual did not appear feasible because of the high reliability in the instruments that would have been needed, and also because of the increased probability of pretest sensitization.

The possibility of a novelty (and disruption) effect (Bracht & Glass, 1968) was taken into account. To counteract a differential effect, efforts were made to distribute it over all the subjects. Equal references were made to the practices of previous years. A few novel features, as described above, were brought into the traditional course, but care was taken to see that they fitted within the philosophy of a course which had goals consisting of basic competencies in the teaching of physical science.

Population

The study was carried out at the Faculty of Education at Åbo Akademi, Vasa, Finland. The subject group consisted of the whole first-year class of

students majoring in elementary education, all of whom follow the same program with very few elective courses. In the spring of 1981, they took the methods course in physics and chemistry that was devoted to this study.

With the ongoing reforms of the school system and academic studies, there is an increasing demand for teachers and an increasing enrollment of students. The available class was the largest one so far, numbering 36 female and 20 male students. For the purposes of group instruction, they were mostly divided into groups of 14 students each. As each group contained both male and female students, the composition of the experimental groups was not conspicuous. In fact, the assignment of students to groups was arranged so that the same groups could be used in concurrent courses. The student counselor, who was responsible for the scheduling of the courses, was helpful in making the arrangements upon the request of the researcher.

The students had been selected to the elementary education program from among 209 female and 48 male applicants, with the quotas set in advance (Meddelanden, 1980). The selection method, also used in previous years, is important for the explanation of a sex bias, e.g., in the distribution of grade averages among the students. On their high school diplomas, the female students had an overall grade average of 8.43 as compared to the male average of 7.74 on a scale that runs from 4 (failing) to 10 (high). Subjected to a *t* test, the difference in means was found significant at the .001 level. In a comparison with their graduating class averages, where available, the female students were clearly above average, whereas the male students had average overall grades.

The mean age during the course was 20.6 years for the female and 21.6 years for the male students. The difference is partly explained by military duty served by a portion of the male students.

Assignment of Students to Groups

The four groups were all taught by the same instructor, the researcher. This fact controlled for instructor variance, but at the same time it necessitated rigorous steps to minimize experimenter effects (Bracht & Glass, 1968).

It was considered essential that the instructor did not know the identities of the high and the low scorers on the instruments used as pretests. The questionnaires used the last four symbols of the social security number for identification, which guaranteed the anonymity of the responders, except that the parity of one of the figures indicated the sex.

The decoding of the symbols was performed by the student counselor, who had access to the files of information about the students. She assembled the list of the names of the students in each group, when the researcher had assigned the subjects as code numbers to the four groups.

In December 1980, the students responded to a questionnaire measuring their self-estimated proficiency in science. On the basis of the scores, the female students were divided into equally numbered groups of high scorers and low scorers, and similarly the male students. The overall cutoff point was also determined, using the median score of all the students. Three female high scorers were found to be overall low scorers, and correspondingly three male low scorers were overall high scorers.

Half the female high scorers were assigned to each of the two kinds of methods course; half the female low scorers were similarly assigned to each of the two kinds of course. The assignments were random, with nine female students in each group. A computer was utilized for the randomization.

The number of male overall high scorers needed in each type of methods course, to make them equal with respect to the total number of overall high scorers, was calculated. The assignments were random.

The remaining male students were randomly assigned to group vacancies.

The method of stratified random assignment of students to groups eliminated the possibility of a systematic bias influencing the composition of the groups. The procedure seemed necessary with regard to the use of the same groups in other courses. The groups were unbiased with respect to both sex and self-estimated proficiency in science. With respect to actual proficiency in science, however, the procedure could not guarantee an unbiased composition.

The test measuring actual proficiency in science was given during the first meeting of each group. On the basis of the results, the students were identified as overall high scorers or overall low scorers. There were 15 high scorers and 13 low scorers in the traditional course, and the other way around in the humanistic course.

Instrumentation

No suitable instruments were available in Finland to measure self-estimated proficiency in science as one of the independent variables or anxiety specific to the teaching of science as the dependent variable. Using foreign instruments, any information about reliability and validity would have been rendered doubtful in the process of translation. Although some of the instruments used in related studies in the United States came fairly close to measuring the desired constructs, none was directly applicable, and the use of instruments especially designed for this study was found preferable.

Self-estimated Proficiency in Science (SEPS)

The instrument designed by Dillon and James (1977) to measure self-estimates of proficiency in science, as part of a measure of the attitudes of black students toward science, was used as a conceptually appropriate guide. The full instrument could not be obtained, however, and only 13 items were readily available in literature. Most of them were judged to be applicable in Finland. A structure, within which the available items fitted, was identified for the purpose of construction of an extended scale. The self-estimated proficiency in science was seen as referring to the way a person sees himself in the following aspects of science:

1. Aptitude
2. Gathering of information
3. Logical procedures
4. Theoretical applications
5. Practical applications

The second and third category combined refer to the processes of science, the fourth and the fifth to applications.

An instrument of Likert-type, with four items in each category, was constructed. The English version of the scale is given as Appendix B. The construct validity was judged by a panel of professors of education and elementary science at Northern Illinois University.

The reliability of the scale was estimated by administration to 35 second-year students at the Faculty of Education at Åbo Akademi, Vasa, Finland. The arithmetic means of the responses to the items and the coefficients of correlation of each item with the whole test were calculated.

On a scale from 1 (low proficiency) to 5 (high proficiency), the mean response was 2.91. The mean responses on individual items ranged from 2.11 to 3.40. The coefficients of correlation between individual items and the whole test ranged from .244 to .770.

The coefficient alpha (Thorndike & Hagen, 1977) was found to be .863. Using a subsample of 21 students of elementary education, the value of alpha was .897. For their correspoinding scale, Dillon and James reported an alpha of .852.

On the basis of the numerical values obtained, the reliability of the instrument was judged to be good.

Actual Proficiency in Science (APS)

To measure actual proficiency in physics and chemistry, two principal ways of defining it operationally were envisaged. One was to establish what skill and knowledge is necessary in elementary science and to sample that in a suitable manner. The other was to measure achievement on a test in normal secondary school physical science. The latter was presumed to be better correlated with the self-estimated proficiency in science, the students being in their first year at the university and having vague ideas about "environmental studies." The former also would have been too closely related to the typical content of a methods course to be appropriate as a pretest.

The instrument used consisted of 30 items (nos. 1, 2, 5-9, 11-13, 15-19, 21-23, 25, 29-31, 34-37, 43-45, and 48) from the Dunning-Abeles Physics Test (Dunning & Abeles, 1967) and 20 items (nos. 4-5, 7-9, 14, 15, 17, 20, 21, 25, 34, 35, 38, 40, 44-46, 51, and 52) from the Anderson-Fisk Chemistry Test (Anderson & Fisk, 1966). The items were selected on the basis of the item analyses reported in the test manuals and the compatibility with secondary school curricula in physics and chemistry in Finland. They referred to knowledge, understanding, and application, respectively, in proportions similar to those of the original tests. The complete test was given as a pilot

test in the beginning of January, 1981, to a group of 33 secondary school students in their last year of school. The maximum possible score being 50, the mean score of 21.2, the standard deviation of 10.4, and the score range of 41 were considered to give satisfactory discrimination between high and low scorers. The coefficient alpha was calculated to be .925.

Anxiety Specific to the Teaching of Science (ASTS and RATS)

Procedures to construct an instrument to measure anxiety specific to the teaching of science were begun in 1978 at Northern Illinois University. The construct was operationally defined using categories of concerns specific to the teaching of science, as compounded from literature analyzing the attitudes of preservice elementary teachers toward teaching science. A total of 13 categories were identified:

1. "teaching science relative to other subjects"
2. "failure in performance"
3. "future shock"
4. "competence in science"
5. "threat to self-esteem"
6. "fear that the personal attributes are unsuitable for science teaching"
7. "concerns about correctness of presentation"
8. "unfamiliarity with equipment"
9. "problems with organizing for science"
10. "problems with classroom management when teaching science"
11. "uncertainty about curriculum"
12. "concerns about the relevance of the content to the students"
13. "concerns about individual attributes of students with regard to science"

A questionnaire (Appendix C) consisting of 40 items, three for each category of concerns except category 1, was administered to 75 students finishing parallel methods courses in science at Northern Illinois University. The responses were scored from 1 (low) to 5 (high concern).

For each item the difficulty (the average degree of concern) and the index of discrimination (the coefficient of correlation between student scores on

the item and on the whole test) were calculated. The overall average difficulty was 2.401 and the coefficient alpha was calculated to be .899.

As a result of the item analysis and following reinspection of the questionnaire, items and categories were removed as unsatisfactory. The criteria for removal were one or more of the following:

- low power of discrimination between high and low scorers,
- low average index of concern in a category (categories 2 and 3),
- risk of contamination with the independent variable (category 4),
- vagueness as judged by respondents.

Other items were removed for a different reason. Category 1 and one additional item which also could be interpreted as a comparison all showed high power of discrimination and expressed concerns of considerable importance. This fact suggested that further comparisons would give more information about anxiety specific to the teaching of physical science relative to anxiety specific to the teaching of other subjects. It was decided that those comparisons would be asked for with a separate instrument, to be described below.

The remaining questionnaire consisted of 27 items, some of which were slightly rewritten for clarity.

After translation into Swedish, in November 1980 the instrument was administered to a group of 18 third-year students at the Faculty of Education at Vasa. Although the individual items had been tested in the United States, it was felt that the different cultural and educational setting of Finland necessitated a further check. The results showed one item, "I will be able to teach science without the support of a textbook," to be completely unusable in Finland because of an almost uniform (negative) answer pattern. In the United States that item had proved to be a very good one.

Two other items were also eliminated, due to correlations with the whole test lower than .20. The coefficient alpha for the remaining test consisting of 24 items was calculated to be .848. Each of the remaining nine categories of concern was still represented by at least two, and no more than three items. Although short, the questionnaire thus was judged to be a representative sample of the types of concerns postulated to build up the construct "anxiety specific to the teaching of science."

Face validity of the Swedish version of the test was assured by having it examined by three teacher educators in Finland, and the new English version (ASTS, Appendix D) was scrutinized by a panel of professors of education and science at Northern Illinois University in the same respect.

A comparison of the anxiety specific to the teaching of physical science with anxieties specific to teaching other subjects was considered necessary in the following sense. The quantitative measures obtained with the ASTS questionnaire would partly reflect a variable which may not be greatly affected by a single methods course, the overall anxiety for teaching. The study did not include a measure of that variable. However, its importance was established indirectly through the amount of correlation of the ASTS with information about the relative anxiety for teaching (physical) science (RATS). Using other subjects as references, the latter construct is independent of the overall anxiety for teaching.

The comparison called for was patterned after Markle (1978) and utilizes forced comparisons between the various subjects taught by elementary school teachers. The instrument is the one described in the statement of the problem in Chapter I, and a translation is given in Appendix E. Respondents encircle the subject they feel more insecure about with respect to teaching in each of the 105 presented pairs. The maximum score for each subject is 14.

Instruments of this type usually show high reliability when all the possible comparisons are made, as people have rather stable opinions about their subject preferences. The reliability is typically reported with a coefficient of consistency, κ (Ferguson, 1966, p. 228), and with a test-retest coefficient of correlation.

The test was given in April 1979 to 28 female and 14 male first-year students of elementary education in Finland. The average coefficient of consistency was .949 for the female and .906 for male students, with an overall average of .935. The individual values were significant at the .001 level, except for one male case which was significant at the .01 level.

Two weeks later the test was readministered to 19 female and 9 male students among those present on the first occasion. Using the 105 pairwise comparisons for each student, and counting those that had changed in direction, the average value of Kendall's τ (Noether, 1967) was calculated to be .738 for the female and .723 for the male students, with an overall average of

.734. The individual values of τ were all significant at the .01 level, except for one female case which was significant at the .05 level.

The reliability estimates above are appropriate for a total ranking of the subjects. However, considering only the relative anxiety for teaching physical science, the score of interest results from just 14 mutually independent comparisons of physics and chemistry with other subjects. The probability for a single comparison to turn out the same way when repeated is .5, if the responses are completely random. Using the binomial distribution, the probability of x or fewer reverslas then gives an estimate of the reliability of the score of an individual with x reversals:

x	0	1	2	3	4
$P(X < x)$	.00006	.00092	.00646	.02868	.08978

The average number of reversals was 1.84 for the female, 2.33 for the male, and 2.00 for all students. Thus, the average probability that the applications were independent is less than or on the order of .01.

Another way of calculating the reliability is to use the number of times physics/chemistry was circled on the two applications as raw data and to calculate the product-moment coefficient of correlation, without regard to the origin of the scores. The coefficients of correlation arrived at were .891 for the female, .804 for the male, and .865 for all students. These values are all significant at the .01 level.

With a pooled standard deviation (based on both applications of the test for 28 students) of 3.91, the standard error of measurement (Stanley, 1971, p.381) was found to be 1.44.

This last view ties in closely with the way the instrument was used. The method of forced comparisons certainly does not give rise to interval data, especially not if a total rank order of the subjects for one individual is sought, as the comparisons are then mutually dependent. However, when a subscale consisting of the comparisons that involve one subject is used, the forced choices are independent of each other. The situation is similar to a test consisting of 14 items to be solved. In such cases it is common to use the number of items solved as raw data, regardless of item difficulties. With regard to the statistical efficiency that could be gained, the scores obtained for physics/chemistry with the instrument were treated as interval data measuring the RATS.

Null Hypotheses

The research hypotheses of Chapter I are restated here in null form. For easy notation, the initial letter H is eliminated from the identifier of each hypothesis, when the hypothesis is expressed in null form.

Main Hypotheses

1. Students with high scores on their self-estimated proficiency in science will not show less anxiety specific to the teaching of science than students with low scores on their self-estimated proficiency in science.
2. There is no difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization.
3. There is no interaction between the effects of the self-estimated proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

1a. Female students with high scores on their self-estimated proficiency in science will not show less anxiety specific to the teaching of science than female students with low scores on their self-estimated proficiency in science.

2a. There is no difference in the degree of anxiety specific to the teaching of science between female students given a methods course emphasizing basic competencies and female students given a methods course aiming toward self-actualization.

3a. With respect to female students, there is no interaction between the effects of the self-estimated proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

Side Hypotheses

1b. Male students will not show less anxiety specific to the teaching of science than female students.

2b. There is no difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization.

3b. There is no interaction between the effects of sex and the type of methods course given on the degree of anxiety specific to the teaching of science.

1c. Students with high scores on their actual proficiency in science will not show less anxiety specific to the teaching of science than students with low scores on their actual proficiency in science.

2c. There is no difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization.

3c. There is no interaction between the effects of the actual proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

4. The score on the self-estimated proficiency in science is no better predictor of anxiety specific to the teaching of science than sex or the score on the actual proficiency in science.

In the event that hypothesis 2 was refuted, hypothesis 4 was to be examined separately for students given a methods course emphasizing basic competencies and for students given a methods course aiming toward self-actualization. It is to be noted that hypothesis 1 and its alternative forms were one-sided.

Statistical Techniques

Except for the preliminary item analysis performed at the Testing Service at Northern Illinois University, all the computations were done using an

ABC-80 microcomputer at the Faculty of Education at Abo Akademi, Vasa, Finland. Several programs were written and prechecked especially for this study. They included programs for storing data on files, calculation of descriptive statistics and reliability estimates, multiple regression analysis, and two-way analysis of variance.

In testing the hypotheses, the level of significance was set at .05.

The scores on the ASTS questionnaire and the RATS were kept apart and used separately to interpret the results. This was done in accordance with the recommendation by Bracht and Glass (1968, p. 465) to use more than one instrument to measure the dependent variable. The prime benefit to be gained is improved generalizability of experimental results. Thus,the measurements of anxiety specific to the teaching of science involved an ASTS score in the range 24-120 and a RATS score in the range 0-14. To test hypotheses 1-3 and their alternative hypotheses, the effects of the different combinations of independent variables on each of the scores were calculated.

Hypotheses 1-3: With SEPS (categories high/low) and type of methods course as independent variables, a two-way ANOVA (Glass & Stanley, 1970, p.400) was performed. The number of entries in each cell was 14.

Hypotheses 1a-3a: A similar ANOVA was performed, with $n = 9$ in each cell.

Hypotheses 1b-3b: With sex and type of methods course as independent variables, a two-way ANOVA with proportionate cell frequencies (Glass & Stanley, 1970, p. 432) was performed. Two of the cells contained 18 (female) entries each, and two contained 10 (male) entries each.

Hypotheses 1c-3c: With APS (categories high/low) and type of methods course as independent variables, a two-way ANOVA with disproportionate cell frequencies (Glass & Stanley, 1970, p. 439) was performed. The cells contained 15 entries (twice) or 13 entries (twice).

Hypothesis 4: The multiple correlation coefficient R (Kerlinger & Pedhazur, 1973) was calculated to determine the proportion of the variance of the dependent variable, as measured with ASTS and RATS, that could be explained by the three attribute variables SEPS, sex, and APS. The original test data were used, i.e., the proficiency variables were not dichotomized. SEPS involved a score in the range 20-100, APS a score in the range 0-50, and sex was treated as a dummy variable taking the value 0 (female) or 1 (male).

The intercorrelations of the variables were calculated. Conclusions regarding the best single predictors were drawn from the coefficients of correlation with ASTS and RATS. The significance of the differences between the coefficients of correlation was investigated using the statistic

$$z = \frac{n(r_{ab}-r_{ac})}{\sqrt{(1-r_{ab}^2)^2(1-r_{ac}^2)^2-2r_{bc}^3-(2r_{bc}-r_{ab}r_{ac})(1-r_{ab}^2-r_{ac}^2-r_{bc}^2)}}$$

(Glass & Stanley, 1970, p. 313), where n is the sample size, and r_{ab}, r_{ac}, and r_{bc} are coefficients of correlation, a denoting ASTS or RATS, b denoting SEPS, and c denoting sex or APS.

A forward multiple regression analysis (Kerlinger & Pedhazur, 1973, p. 285) was performed to establish whether use of more than one variable as predictor gave significant increases in the proportion of variance explained. In so doing, the results from the analyses of the previous hypotheses were taken into account.

CHAPTER IV

Findings and results

Background Information

In the comparison of the effects of the two methods courses, an important feature was the anonymity of the responses to the various instruments applied. As research subjects the identities of the students were represented by the last four symbols of their social security numbers. This anonymity had been guaranteed whenever an instrument was administered, and it was respected throughout the study.

Based on the social security numbers, a division into four groups was possible, and it was peformed by the student counselor. The group structure gave each student another identity, represented by his name. In the instructor role, the researcher used the names and had no need for social security numbers.

Some background information was gathered from files, using the names of the students. As a consequence of the procedure, that information could not be correlated with information based on social security numbers. However, its importance for the study is to describe the population. The information is concerned with variables not referred to in the hypotheses and of only indirect relevance for the application of the Maslow theory of basic needs to methods courses in science.

The age of each student in March, 1981, was calculated with an accuracy of one decimal place. The oldest male student was 25.6 years of age, the youngest being 19.3 years. The corresponding numbers for the female students were 23.0 years and 18.6 years, respectively. The mean ages, distributed over sex and type of methods course, are shown in Table 3.

Table 3

Mean Ages of the Prospective Elementary Teachers

	Traditional Course	Humanistic Course	Total
Female	20.5	20.8	20.6
Male	21.7	21.5	21.6
Total	20.9	21.0	21.0

Using a *t* test, the difference in mean age between female and male students was found to be significant at the .01 level, whereas the distribution on course type showed no significant difference.

The overall grade averages on the high school diplomas, as reported on the applications for matriculation by the students themselves, were also investigated. The highest male average was 8.6 and the lowest 6.9. The corresponding numbers for the female students were 9.4 and 7.4. The distribution over sex and type of methods course is given in Table 4.

Table 4

Mean Overall Grade Averages of the Prospective Elementary Teachers

	Traditional Course	Humanistic Course	Total
Female	8.45	8.42	8.43
Male	7.90	7.58	7.74
Total	8.25	8.12	8.19

Using a *t* test, the difference in mean overall grade average between female and male students was found to be significant at the .001 level, whereas the distribution on course type was not significantly different. The difference in the mean overall grade average of the male students between the two kinds of course, although conspicuous, was not significant.

Table 5

Item Analysis of SEPS Instrument

Item	Mean Score[a]	Standard Deviation	Index of Discrimination[b]
1	2.57	1.22	.54
2	3.17	1.20	.49
3	3.26	1.15	.26
4	3.29	.96	.47
5	2.69	1.28	.54
6	3.23	1.11	.59
7	2.69	1.45	.59
8	2.80	1.35	.37
9	2.83	1.18	.58
10	2.69	1.30	.62
11	3.23	1.24	.71
12	2.77	1.17	.56
13	3.31	1.39	.62
14	3.20	1.30	.74
15	2.11	1.21	.77
16	2.89	.99	.50
17	2.69	1.28	.46
18	3.03	1.32	.50
19	2.46	1.31	.34
20	3.40	1.09	.24
Total	58.29	12.94	alpha = .863

[a]Score range 1 (low) - 5 (high SEPS)

[b]Coefficient of correlation with score on whole test

Item Analyses

Self-estimated Proficiency in Science

In November, 1980, the instrument used to measure SEPS (translated in Appendix B) was administered as a pilot test to 35 prospective teachers in

their second year of studies at the Faculty of Education at Vasa, Finland. The group included 21 students of elementary education and 14 students majoring in textile or technical handicrafts. Based on the responses to individual items, an item analysis gave the results shown in Table 5.

ASTS

In May, 1978, a preliminary version of a test designed to measure anxiety specific to the teaching of science was given to 75 students of elementary education finishing parallel methods courses at Northern Illinois University, DeKalb. Based on the results of an item analysis and criteria for removal as described in Chapter III, the number of items was lowered from 40 to 27.

In November, 1980, following an administration of the Swedish version to 18 students of elementary education, in their third year of studies at the Faculty of Education at Vasa, Finland, the number of items was further reduced to 24. The final instrument is given in Appendix D.

Table 6 accounts for the item analyses.

Results of the Pretests

In December, 1980, the instrument measuring self-estimated proficiency in science was administered to the first-year students of elementary education who would be taking a methods course in physics and chemistry during the spring of 1981. The assignment of students to groups was based upon the results of the test and upon sex.

In January, 1981, the instrument measuring actual proficiency in science was administered to each student as a second pretest.

The results of the pretests are summarized in Table 7.

Table 6

Development and Item Analyses of ASTS Instrument

Original Item No.	First Tryout Difficulty[a]	First Tryout Index of Discrimination[b]	First Tryout Standard Deviation	Final Instrument Standard Deviation	Final Instrument Index of Discrimination[b]	Final Instrument Difficulty[a]	Final Item No.
1*	3.69	- .02	1.24				
2**	2.08	.64	1.33				
3	1.59	.49	.80	1.10	.39	3.17	1
4***	3.00	.37	1.02				
5	2.09	.46	.98	1.18	.61	3.28	2
6	1.91	.42	.79	.86	.23	3.56	3
7**	3.05	.41	1.31				
8*	2.60	.46	1.40				
9	1.79	.39	.88	1.25	.56	2.83	4
10	2.59	.56	1.28	1.47	.57	3.50	5
11	1.77	.49	.96	.91	.49	2.33	6
12**	2.37	.39	1.21				
13	2.91	.41	1.38	1.47	.78	2.94	7
14***	2.99	.44	1.44				
15	2.55	.39	1.13	.71	.32	4.17	8
16*	2.04	.22	1.25				
17	1.80	.42	.83	.98	.52	3.17	9
18	1.96	.47	.89	.77	.46	3.67	10
19*	2.60	.34	1.06				
20	1.76	.60	1.02	1.25	.65	2.17	11
21	2.67	.56	.87	.94	.55	4.22	12
22*	2.35	.24	1.19				
23	3.01	.39	.93	1.08	.64	3.33	13
24	2.00	.26	.95	1.13	.21	3.28	14
25	2.28	.45	1.35	1.42	.40	2.61	15
26*	2.87	.37	1.10				
27	2.55	.26	.77	.77	.42	3.33	16
28	3.03	.65	1.30	1.42	.44	3.39	17
29*	2.55	.78	1.30				
30	2.36	.40	1.35	1.02	.51	3.28	18
31	1.84	.71	.88	1.07	.46	2.28	19
32	1.57	.47	.87	.83	.44	1.72	20
33***	2.03	.64	.98				
34	2.25	.49	1.14	1.34	.38	3.50	21
35**	3.25	.56	1.23				
36**	2.48	.68	1.26				
37	2.55	.49	1.09	.71	.23	3.50	22
38	2.69	.48	1.44	1.20	.50	2.83	23
39	2.29	.64	1.12	1.24	.51	3.61	24
40*	2.31	.33	1.12				
Total	96.05	alpha = .899	20.28	12.24	alpha = .848	75.67	

Note. * = eliminated as unsatisfactory
** = eliminated as a comparison (covered by RATS)
*** = removed after second tryout

[a]Mean score on item

[b]Coefficient of correlation with whole test

Table 7

SEPS and APS Data

	SEPS	APS
Range of scale	20 – 100	0 – 50
Highest score	91	39
Lowest score	34	4
Mean score	52.73	14.95
Standard deviation	15.07	7.11
Median score	52	14
Median score, female students	49.5	13.5
Median score, male students	58	15

The assignment to groups was based on a dichotomy in SEPS. Using the full data, the mean structure of the groups of instruction was that of Table 8.

Table 8

Structure of the Groups of Instruction

	Traditional Course	Humanistic Course
Morning group		
Mean SEPS	53.14	52.21
Mean APS	15.36	14.50
Mean grade average[a]	8.31	8.05
Afternoon group		
Mean SEPS	51.64	53.92
Mean APS	14.57	15.36
Mean grade average[a]	8.20	8.19

[a]Obtained from files, using student names as identification.
Standard deviation = .59.

Results of the Posttests

In the first week of May, 1981, during the last regular meeting of each group, the two tests measuring the dependent variable were administered. The results are summarized in Table 9.

Table 9

ASTS and RATS Overall Data

	ASTS	RATS
Range of scale	24 – 120	0 – 14
Highest score	86	13
Lowest score	31	2
Mean score	60.20	8.45
Median score	61	9
Standard deviation	11.17	3.26

The distributions of the ASTS and RATS scores on specific combinations of independent variables were used to test the statistical hypotheses 1-3 and their alternative hypotheses.

Main Hypotheses

1. Students with high scores on their self-estimated proficiency in science will not show less anxiety specific to the teaching of science than students with low scores on their self-estimated proficiency in science.
2. There is no difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization.
3. There is no interaction between the effects of the self-estimated proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

The first three hypotheses connected the variables most directly related to the Maslow theory of basic needs. Self-estimated proficiency in science was dichotomized using the overall median score of 52 as the cutoff point. The mean score of the high-scoring group was 64.54, and that of the low-scoring group was 40.92.

The mean scores on the ASTS questionnaire are shown in Table 10. The number of entries in each cell was 14. A two-way analysis of variance was performed, producing the results shown in Table 11.

The results reported in Table 11 indicated rejection of hypothesis 1 with respect to scores on the ASTS questionnaire, i.e., students with high self-estimated proficiency in science scored significantly lower on the ASTS questionnaire than students with low self-estimated proficiency in science.

Hypotheses 2 and 3 were not refuted. There was no significant difference in ASTS scores between students given the traditional course and students given the humanistic course, nor was there any significant interaction between the effects of the self-estimated proficiency in science and the type of methods course on the ASTS score.

Table 10

Cell Means of ASTS Scores Using SEPS and Type of Methods Course as Independent Variables (All Students Included)

	Traditional Course	Humanistic Course	Total
Low SEPS	64.57	66.50	65.54
High SEPS	55.71	54.00	54.86
Total	60.14	60.25	60.20

Table 11

ANOVA of ASTS Scores (Hypotheses 1-3)

	SS	*df*	*MS*	*F*	Significance
SEPS	1596.45	1	1596.45	15.86	.001
Course	.16	1	.16	.00	n.s.
Interaction	46.45	1	46.45	.46	n.s.
Within	5233.79	52	100.65		
Total	6876.84	55			

The mean scores on RATS are shown in Table 12. The corresponding analysis of variance is reported in Table 13.

Table 12

Cell Means of RATS Scores Using SEPS and Type of Methods Course as Independent Variables (All Students Included)

	Traditional Course	Humanistic Course	Total
Low SEPS	9.57	10.50	10.04
High SEPS	7.71	6.00	6.86
Total	8.64	8.25	8.45

The results of Table 13 indicated rejection of hypothesis 1 with respect to RATS scores, i.e., students with high self-estimated proficiency in science scored significantly lower than students with low self-estimated proficiency in science.

Table 13

ANOVA of RATS Scores (Hypotheses 1-3)

	SS	*df*	*MS*	*F*	Significance
SEPS	141.45	1	141.45	17.61	.001
Course	2.16	1	2.16	.27	n.s.
Interaction	24.45	1	24.45	3.04	n.s.
Within	417.79	52	8.03		
Total	585.84	55			

Hypotheses 2 and 3 were retained. There was no significant difference in RATS scores between students given the traditional course and students given the humanistic course, nor was there any significant interaction between the effects of the self-estimated proficiency in science and the type of methods course on the RATS score (critical value of $F = 4.03$).

The main hypotheses, as limited to female students, were the following:

1a. Female students with high scores on their self-estimated proficiency in science will not show less anxiety specific to the teaching of science than female students with low scores on their self-estimated proficiency in science.

2a. There is no difference in the degree of anxiety specific to the teaching of science between female students given a methods course emphasizing basic competencies and female students given a methods course aiming toward self-actualization.

3a. With respect to female students, there is no interaction between the effects of the self-estimated proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

Self-estimated proficiency in science was dichotomized using the female median score of 49.5 as the cutoff pont. The mean score of the high-scoring group was 56.56 and that of the low-scoring group was 38.9.

The mean scores on the ASTS questionnaire are shown in Table 14. The number of entries in each cell was 9. A two-way analysis of variance was performed, producing the results shown in Table 15.

Table 14

Cell Means of ASTS Scores Using SEPS and Type of Methods Course as Independent Variables (Female Students)

	Traditional Course	Humanistic Course	Total
Low SEPS	63.33	66.00	64.67
High SEPS	56.11	56.11	56.11
Total	59.72	61.06	60.39

Table 15

ANOVA of ASTS Scores (Hypotheses 1a-3a)

	SS	*df*	*MS*	*F*	Significance
SEPS	658.78	1	658.78	7.62	.01
Course	16.00	1	16.00	.19	n.s.
Interaction	16.00	1	16.00	.19	n.s.
Within	2765.78	32	86.43		
Total	3456.56	35			

The results of Table 15 parallel those of Table 11. Hypothesis 1a was rejected with respect to scores on the ASTS questionnaire, i.e., female students with high self-estimated proficiency in science scored significantly lower on the ASTS questionnaire than female students with low self-estimated proficiency in science.

Hypotheses 2a and 3a were not refuted. There was no significant difference in ASTS scores between female students given the traditional course and

female students given the humanistic course, nor was there any significant interaction between the effects of the self-estimated proficiency in science and the type of methods course on the ASTS scores of female students.

The mean scores of the female students on RATS, as distributed over SEPS and type of methods course, are shown in Table 16. The corresponding analysis of variance is reported in Table 17.

Table 16

Cell Means of RATS Scores Using SEPS and Type of Methods Course as Independent Variables (Female Students)

	Traditional Course	Humanistic Course	Total
Low SEPS	8.67	10.22	9.44
High SEPS	8.33	8.33	8.33
Total	8.50	9.28	8.89

Table 17

ANOVA of RATS Scores (Hypotheses 1a-3a)

	SS	*df*	*MS*	*F*	Significance
SEPS	11.11	1	11.11	1.14	n.s.
Course	5.44	1	5.44	.56	n.s.
Interaction	5.44	1	5.44	.56	n.s.
Within	311.56	32	9.74		
Total	333.56	35			

Based on the results of Table 17, none of hypotheses 1a-3a was refuted with respect to RATS scores.

Female students with high self-estimated proficiency in science did not score significantly lower than female students with low self-estimated profi-

ciency in science. There was no significant difference in RATS scores between female students given the traditional course and female students given the humanistic course, nor was there any significant interaction between the effects of the self-estimated proficiency in science and the type of methods course on the RATS scores of female students.

To aid the interpretation of the results of Tables 14 to 17, which are dependent on the female cutoff point 49.5 in the SEPS scores, a corresponding analysis using the overall cutoff point 52 was performed. Although not used to test specific hypotheses, the information was considered relevant for an understanding of the effect of the arbitrary cutoff point. The results of the analyses are summarized in Tables 18 to 21.

Table 18

Cell Means of ASTS Scores Using SEPS and Type of Methods Course as Independent Variables (Female Students, Overall Cutoff Used)

	Traditional Course	(*n*)	Humanistic Course	(*n*)	Total	(*n*)
Low SEPS	63.10	(10)	65.27	(11)	64.24	(21)
High SEPS	55.50	(8)	54.43	(7)	55.00	(15)
Total	59.72	(18)	61.06	(18)	60.39	(36)

Table 19

ANOVA of ASTS Scores Using SEPS and Type of Methods Course as Independent Variables (Female Students, Overall Cutoff Used)

	df	*MS*	*F*	Significance
SEPS	1	85.05	8.85	.01
Course	1	.30	.03	n.s.
Interaction	1	2.63	.27	n.s.
Within	32	9.61		

Table 20

Cell Means of RATS Scores Using SEPS and Type of Methods Course as Independent Variables (Female Students; Overall Cutoff Used)

	Traditional Course	(*n*)	Humanistic Course	(*n*)	Total	(*n*)
Low SEPS	8.90	(10)	10.64	(11)	9.81	(21)
High SEPS	8.00	(8)	7.14	(7)	7.60	(15)
Total	8.50	(18)	9.28	(18)	8.89	(36)

Table 21

ANOVA of Rats Scores Using SEPS and Type of Methods Course as Independent Variables (Female Students; Overall Cutoff Used)

	df	*MS*	*F*	Significance
SEPS	1	4.83	4.94	.05
Course	1	.19	.20	n.s.
Interaction	1	1.68	1.72	n.s.
Within	32	.98		

Two-way ANOVA with disproportionate cell frequencies was employed. As the number of entries in the different cells deviated rather little from each other, the use of unweighted cell means (Glass & Stanley, 1970, p. 440) was considered appropriate. In such an analysis, the observations of each cell are replaced by their arithmetic mean only, after which a normal ANOVA is carried out. The mean square variance within cells, however, is obtained from the original set of data.

Side Hypotheses

Besides entering control of sex in testing the main hypotheses, sex was also used as an alternative to SEPS as the independent attribute variable. The relevant hypotheses were the following:

1b. Male students will not show less anxiety specific to the teaching of science than female students.
2b. There is no difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization. (The hypothesis was mathematically identical with hypothesis 2.)
3b. There is no interaction between the effects of sex and the type of methods course given on the degree of anxiety specific to the teaching of science.

The mean scores on the ASTS questionnaire are shown in Table 22. The number of entries in the female cells was 18, in the male cells, it was 10. A two-way analysis of variance with proportionate cell frequencies was performed, producing the results shown in Table 23.

Table 22

Cell Means of ASTS Scores Using Sex and Type of Methods Course as Independent Variables

	Traditional Course	Humanistic Course	Total
Female students	59.72	61.06	60.39
Male students	60.90	58.80	59.85
Total	60.14	60.25	60.20

Table 23

ANOVA of ASTS Scores (Hypotheses 1b-3b)

	SS	*df*	*MS*	*F*	Significance
Sex	3.73	1	3.73	.03	n.s.
Course	.16	1	.16	.00	n.s.
Interaction	37.89	1	37.89	.29	n.s.
Within	6835.06	52	131.44		
Total	6876.84	55			

Hypothesis 1b was retained with respect to scores on the ASTS questionnaire, i.e., male students did not score significantly lower than female students.

The testing of hypothesis 2b duplicated the result from the testing of hypothesis 2.

Hypothesis 3b was not refuted, either. There was no significant interaction between the effects of sex and the type of methods course on the ASTS score.

The mean scores on RATS are shown in Table 24. The corresponding analysis of variance is reported in Table 25.

Table 24

Cell Means of RATS Scores Using Sex and Type of Methods Course as Independent Variables

	Traditional Course	Humanistic Course	Total
Female students	8.50	9.28	8.89
Male students	8.90	6.40	7.65
Total	8.64	8.25	8.45

The results of Table 25 indicate that both hypothesis 1b and hypothesis 3b withstood the testing with respect to RATS.

Table 25

ANOVA of RATS Scores (Hypotheses 1b-3b)

	SS	*df*	*MS*	*F*	Significance
Sex	19.73	1	19.73	1.94	n.s.
Course	2.16	1	2.16	.21	n.s.
Interaction	34.53	1	34.53	3.39	n.s.
Within	529.41	52	10.18		
Total	585.84	55			

Male students did not score significantly lower than female students, and there was no significant interaction between the effects of sex and type of methods course.

Using actual proficiency in science as an alternative independent variable, the relevant hypotheses were the following.

1c. Students with high scores on their actual proficiency in science will not show less anxiety specific to the teaching of science than students with low scores on their actual proficiency in science.

2c. There is no difference in the degree of anxiety specific to the teaching of science between students given a methods course emphasizing basic competencies and students given a methods course aiming toward self-actualization. (The hypothesis was mathematically identical with hypothesis 2.)

3c. There is no interaction between the effects of the actual proficiency in science and the type of methods course given on the degree of anxiety specific to the teaching of science.

Actual proficiency in science was dichotomized using the overall median score of 14 as the cutoff point. Five students scored exactly 14 points. Three of them, selected at random, were designated high scorers. The mean score of the high-scoring group was 19.93, and that of the low-scoring group was 9.96.

The mean scores on the ASTS questionnaire are shown in Table 26. A two-way analysis of variance with disproportionate cell frequencies was performed, producing the results reported in Table 27.

Table 26

Cell Means of ASTS Scores Using APS and Type of Methods Course as Independent Variables

	Traditional Course	(*n*)	Humanistic Course	(*n*)	Total	(*n*)
Low APS	61.85	(13)	61.20	(15)	61.50	(28)
High APS	58.67	(15)	59.15	(13)	58.89	(28)
Total	60.14	(28)	60.25	(28)	60.20	(56)

Table 27

ANOVA of ASTS Scores (Hypotheses 1c-3c)

	df	*MS*	*F*	Significance
APS	1	6.83	.73	n.s.
Course	1	.01	.00	n.s.
Interaction	1	.32	.03	n.s.
Within	52	9.36		

Hypothesis 1c was not refuted. Students with high APS scores did not score significantly lower on the ASTS questionnaire than students with low APS scores.

The testing of hypothesis 2c repeated the testing of hypothesis 2, using a different kind of analysis of variance.

Hypothesis 3c was not refuted. There was no significant interaction between the effects of APS and type of methods course on the ASTS score.

The cell means of the RATS score are shown in Table 28. The corresponding analysis of variance is reported in Table 29.

Table 28

Cell Means of RATS Scores Using APS and Type of Methods Course as Independent Variables

	Traditional Course	(*n*)	Humanistic Course	(*n*)	Total	(*n*)
Low APS	8.85	(13)	9.27	(15)	9.07	(28)
High APS	8.47	(15)	7.08	(13)	7.82	(28)
Total	8.64	(28)	8.25	(28)	8.45	(56)

Table 29

ANOVA of RATS Scores (Hypotheses 1c-3c)

	df	*MS*	*F*	Significance
APS	1	1.65	2.18	n.s.
Course	1	.23	.31	n.s.
Interaction	1	.82	1.08	n.s.
Within	52	.76		

The results of Table 29 indicated retention of hypothesis 1c as well as hypothesis 3c with respect to RATS scores.

Students with high APS scores did not score significantly lower than students with low APS scores, and there was no significant interaction between the effects of APS and type of methods course on the RATS score.

The last hypothesis was the following:

4. The score on the self-estimated proficiency in science is no better predictor of anxiety specific to the teaching of science than sex or the score on the actual proficiency in science.

The artificial dichotomies involved in testing the previous hypotheses were expected to sacrifice a lot of information in the raw data. Hypothesis 4, which was less concerned with pragmatic aspects, seemed better suited to a treatment that took advantage of all the possible information, and thus SEPS and APS were not dichotomized.

A matrix of correlations between the independent variables and the measures of the dependent variable is shown in Table 30. As hypothesis 2 had not been rejected previously, the coefficients of correlation were calculated using the responses from all the students, regardless of the type of methods course. For informative purposes, the correlations with the experimental variable are also included. Like sex, it was treated as a dummy variable.

With respect to ASTS, self-estimated proficiency in science was the best predictor, explaining 12 percent of the variance. Using the Fisher z-transformation for dependent samples (page 68) to test for significance, SEPS was found to be a significantly better predictor than sex ($z = -2.187$), but it was not significantly better than APS ($z = -.311$).

Table 30

Matrix of Correlations Between the Variables

	SEPS	Sex[a]	APS	Course[b]	ASTS
Sex	-.293*				
APS	.689***	.170			
Course	.023	0	-.003		
ASTS	-.351**	-.023	-.321*	-.005	
RATS	-.386**	-.184	-.417**	-.061	.581***

Note. * $p = .05$
** $p = .01$
*** $p = .001$

[a]Female = 0, male = 1
[b]Traditional = 0, humanistic = 1

With respect to RATS, the best predictor was actual proficiency in science, which accounted for 17 percent of the variance. It was not, however, a significantly better predictor than SEPS (z = -.325). SEPS, accounting for 15 percent of the variance, was not found to be a significantly better predictor of RATS than sex (z = -1.364).

There was no significant difference in the power of prediction between APS and sex (z = -1.814 and z = -1.471 for ASTS and RATS, respectively).

A forward multiple regression analysis was performed on the scores of each of the dependent measures.

Entering SEPS as the first predictor of ASTS, it was found that neither sex nor APS added significantly to the proportion of variance explained. The semipartial coefficients of correlation were -.044 and -.109 respectively, the latter implying an increase of 1 percent in the explained variance of ASTS.

Using APS as the first predictor of RATS, a similar result followed. Neither SEPS nor sex brought significant additional contributions to the proportion of variance explained. The semipartial coefficients of correlation were -.136 and -.114, respectively, the former implying less than a 2 percent increase in the explained variance of RATS.

Tables 31 and 32 summarize the information obtained from the multiple regression analyses.

Table 31

Multiple Regression of ASTS on the Independent Attribute Variables

	Step In	Multiple R	R^2	R^2 Increase	F	β	b
SEPS	1	.351	.123	.123	7.61	-.276	-.204
APS	2	.368	.135	.012	.72	-.145	-.228
Sex[a]	3	.376	.141	.006	.37	-.082	1.893
						constant =	73.692

[a]Female = 0, male = 1.

Table 32

Multiple Regression of RATS on the Independent Attribute Variables

	Step In	Multiple R	R^2	R^2 Increase	F	β	b
APS	1	.417	.174	.174	11.35	-.293	-.134
SEPS	2	.438	.192	.019	1.22	-.159	-.034
Sex[a]	3	.446	.199	.007	.46	-.087	-.590
						constant = 12.476	

[a]Female = 0, male = 1.

With respect to RATS, two of the previous analyses (Tables 12, 24) showed results in the form of interaction effects which, although not significant at the .05 level, were of rather low probability ($p < .1$). The three interactions were investigated again with the full information of the raw data. The coefficients of correlation between the RATS score and terms of the form (attribute variable) x (type of methods course) were found nonsignificant, except for a coefficient of -.295, when the attribute variable was sex. Allowing interaction terms in the multiple regression analysis, the term sex x course proved to be a significant second predictor with a semipartial coefficient of correlation of -.248 and an explained proportion of variance of 6 percent. No similar effect was found with respect to the ASTS scores.

Table 33 lists the best significant predictors of the dependent measures.

Table 33

Significant Results of the Multiple Regression Analyses

Dependent Measure	Significant Predictor	Multiple R	R^2	R^2 Increase	F	Significance
ASTS	SEPS	.351	.123	.123	7.61	.01
RATS	APS	.417	.174	.174	11.35	.01
	sex x course	.485	.235	.061	4.27	.05

Additional Comparisons

Although not part of the study proper, the outcome of the final examination constitutes a piece of ex post facto information having some relevance when the results of the study are discussed. It is to be noted that the low emphasis on evaluation in combination with a short exam (three essay questions) make the scores unreliable as measures of achievement. As it happened, all the 56 students who had taken either of the courses were present when the exam was given.

The results could not be correlated with information based on social security numbers, i.e., SEPS, APS, ASTS, or RATS. A matrix of correlations including some other variables is given in Table 34.

It was found that the score on the final examination was strongly correlated with sex (female students peforming better), and with the grade average on the high school diploma. There was no significant correlation between the score on the final examination and the type of methods course given.

Table 34
Correlations with Final Exam

	Sex[a]	Course[b]	Grade Average on High School Diploma
Course	0		
Grade average	-.573***	-.117	
Final exam[c]	-.465***	-.080	.447***

[a]Female = 0, male = 1 [b]Traditional = 0, humanistic = 1
[c]Score in the range 0-10. Mean = 7.91. Standard deviation = 2.04.
***p = .001

CHAPTER V

Summary, discussion, and implications

Summary

This study was concerned with the construct anxiety specific to the teaching of science, as evidenced in preservice elementary school teachers in Finland. Physical science, although a minor subject in the elementary school curriculum, has been associated with considerable teaching insecurity, not alleviated by recent changes in the school system and the teacher education institutions of Finland. The problem was seen as related to an international alienation between scientists and non-scientists (Snow, 1961).

The distinction between insecurity with respect to science and insecurity with respect to teaching science was analyzed. The former was seen as a reflection of previous experiences of science in school and in society in general, a mental set coming with the prospective teacher when he enters teacher training. The latter, on the other hand, referred to expectations of future insecurity in the teacher role. As it was concerned with recognition of specific threats, it was termed anxiety specific to the teaching of (physical) science.

The Maslow theory of basic needs was seen as applicable to both of these constructs. Persons motivated by the need for security in science would not function on a higher need level until the more basic need was satisfied, and persons expecting to feel insecure as teachers of science would have no serious thought of science teaching as a means for personal growth or self-actualization.

An individual's perception of his own level of functioning with respect to science, his self-estimated proficiency in science (SEPS), was the main independent attribute variable of the study. It was hypothesized that a "traditional" course was suitable to students with low self-estimated proficiency in

science, whereas a "humanistic" course would be appropriate for students with high self-estimated proficiency.

The experimental variable was defined by the two types of methods course. The "traditional" course emphasized basic competencies in teaching science, whereas the "humanistic" course strived toward self-actualization. Both types of methods course were given to groups of students that included equally many students with low SEPS and students with high SEPS. The relative effects of the two types of methods course were measured in terms of anxiety specific to the teaching of science at the end of the courses.

The study was rather heavily directed by the particular circumstances it was performed under, a major purpose being course development at the Faculty of Education at Åbo Akademi, Vasa, Finland. It was projected that no more than two concurrent types of methods course would be feasible in the future. The dichotomy imposed on SEPS was thus based on an effort to obtain similarity between the experimental situation and possible future practice. The study was also somewhat influenced by the fact that the experimental group structure was used in parallel courses of the regular program of the students.

It was further recognized that the construct self-estimated proficiency in science might be too crude a measure on which to base educational decisions. Two other independent attribute variables were introduced as alternatives that were more clearly defined operationally. Actual proficiency in science (APS) was defined as the score on an achievement test in high school physics and chemistry. It was also subjected to a dichotomy. The other alternative variable was sex, the importance of which was indicated in literature and in a pilot test.

The study included the development and testing of three researcher-made instruments:

1. The SEPS questionnaire, consisting of 20 items referring to the way a person sees himself in five different aspects of science.
2. The ASTS questionnaire, consisting of 24 items based on nine categories of concern with respect to the teaching of science. It went through a two-step tryout at Northern Illinois University and in Finland.

3. An instrument employing forced comparisons between the insecurities felt with respect to teaching various subjects. The score for physics/chemistry constituted the relative anxiety for teaching science (RATS). It was seen as independent of overall anxiety for teaching.

Reliability estimates of the instruments were calculated and deemed satisfactory. Validations were performed with regard to construct validity only.

The study also involved the production of the major part of the course materials utilized in the experimental courses.

The humanistic course had its theoretical basis in the humanistic philosophies of education represented by Maslow, Combs, and Rogers. The translation into a science setting was that of McCormack (1973). The course featured selection of individual goals, a large choice of activities geared to the goals, self-evaluation, concentration on the personal meaning of the activities performed, knowledge of self in the form of computer-based attitude inventories, and lectures boosting the importance of teaching science as a means for self-actualization.

The traditional course involved emphasis on basic competencies in teaching science, as identified using needs and importance assessments in the literature, the new national curriculum for environmental studies, and the inherent structure of the topic areas. Students were directed to specific activities geared to the basic competencies. The importance of the activities for the classroom situation rather than for personal growth was stressed. Science content entered in the form of computer-based instruction and lectures covering selected topic areas. Other lectures had been used in corresponding courses in previous years.

Some of the features of the courses were made superficially similar to counteract the impression of an experiment and to spread novelty effects over both types of course. The courses also occupied the same premises and had many materials in common, although they were used differently.

The fact that the courses were taught by the same instructor, the researcher, controlled for instructor variance, but it also made specific arrangements necessary to control for experimenter effects.

The study employed a posttest only control group design, investigating the effects on the two measures of the dependent variable (ASTS and RATS) of

various combinations of independent variables. It constituted a total investigation of those first-year students at the Faculty of Education at Abo Akademi, Vasa, Finland, that were enrolled in September, 1980. To make generalizations of the results possible, statistical methods presupposing random selection were utilized – on one hand the group of subjects was seen as a sample in time, on the other it was viewed as a sample from a set of teacher education institutions with similar practices.

Discussion

An evaluation of the applicability of a theory to a special problem in education can take place at more than one level.

A prerequisite for implementation of theory is satisfactory correspondence between the elements of the theory and those of the application. In the present work, a correspondence was presumed to exist between the basic needs of the Maslow theory and levels of functioning with respect to science and science teaching. The study did not put that basic assumption to test.

However, applicability also includes successful operational definitions of the constructs employed. The development of appropriate instruments was a necessary part of the study, as was indicated in the review of literature. The discussion of the findings and results will consider the instruments, the interrelationship of the two measures of the dependent variable as well as the interrelationships between the independent attribute variables, and the results of the tests of the hypotheses.

Instruments

The use of researcher-made instruments for the measurement of several variables had both negative and positive aspects. From the negative side, comparisons with other research are difficult to make. From the positive side, the instruments were designed to fit specific constructs derived from theory, and their construct validity thus was more immediate than that of alternative instruments, which had been designed for slightly different purposes.

Comparing the development of the two questionnaires, it is to be noted that the original version of the SEPS instrument remained the final one, with the item analysis giving very satisfactory results. The items were directly written in Swedish. The ASTS instrument went through two tryouts, including a preliminary version in English. The number of items had to be decreased, partly due to quality control and partly due to branching when the instrument measuring RATS was introduced. The efforts involved in producing the instrument were considerably larger than for the SEPS questionnaire. The item analyses reveal the instruments to have almost equal reliability and power of discrimination between high and low scorers. The ASTS, however, has been tested in two kinds of educational environment, the SEPS only in one.

Both questionnaires were deemed to be reliable and valid instruments, and they should be useful in future research concerning self-estimated proficiency in science and anxiety specific to the teaching of science.

The instrument behind the RATS score was the only one that was subjected to a retest reliability estimate. The test-retest coefficient of correlation between the scores in physics/chemistry was found to be .865. The instrument is thus satisfactory for analyses of changes in RATS for individual students over periods of time. In this study it was primarily used to determine average scores in groups of students. The relatively large variation in RATS scores within any such group provided for cruder measurement. When RATS scores of individual students were correlated with other individual measures, as in the multiple regression analysis, more detailed structure was revealed.

The APS instrument had a coefficient alpha of .925 which, although high, is normal for an achievement test in science. The pilot test with high school students gave a larger spread in the scores than the actual application of the instrument (standard deviations 10.38 and 7.11, respectively) as well as a higher mean score (21.21 as compared to 14.95). This includes the effect of time on retention, but it may also reflect the inclinations of persons going into teacher training. In comparison with the SEPS instrument, the APS instrument was less successful in distinguishing between high and low scorers.

Interrelationships Between Variables

The coefficient or correlation between the ASTS and the RATS scores was found to be .581, indicating moderate to high association between the two measures of the anxiety specific to the teaching of science. The RATS constituted a partial check on the validity of the ASTS questionnaire, with focus on the specificity of the construct to physical science. It may be judged acceptable – at least 34 percent of the variance of the ASTS scores was disjunct from variance due to overall anxiety for teaching.

Similarly, it may be argued that the method of forced comparisons between subjects, although expressedly with respect to teaching them, is likely to result in disregard of the reference to the future occupation. In that respect the ASTS served as a partial check on the validity of the RATS, and the coefficient of correlation obtained was high enough to be satisfactory. It was, however, also small enough to allow different interpretations of the results obtained with each measure. The ASTS results are seen as measures of the absolute levels of anxiety specific to the teaching of science, whereas the RATS scores qualify those results by determining relative levels.

A corresponding analysis of coefficients of correlations may be made between the measures of the independent attribute variables. The coefficients of correlation were found to be .293 between SEPS and sex, .689 between SEPS and APS, and .170 between sex and APS, the first two being statistically significant. The construct self-estimated proficiency in science thus has both sex and actual proficiency in science as correlates. The association between self-estimated and actual proficiency was found to be high, indicating realistic self-perceptions among the students as far as high school physics and chemistry go.

The non-significant correlation between sex and APS has to be interpreted in view of the biased enrollment of students with respect to sex. In a different kind of population the male students may not have lower grade averages on their high school diplomas, and it would be likely to be reflected in a higher correlation between sex and APS. The conclusion with regard to the population of study is clearly one of non-significant correlation, but seen in a larger context the results do not exclude the possibility that male students have significantly higher proficiency in science than female students.

A similar adjustment of interpretation may be appropriate with respect to the coefficient of correlation between SEPS and sex. Significant as it is, the association may be even stronger in a different kind of population, judging from the coefficient of correlation between SEPS and APS.

The Tests of the Hypotheses

A major result of the study was the finding of no significant main effect of the experimental variable, i.e., there was no indication of either type of methods course being superior to the other, as measured with ASTS or RATS.

The studies by McClain (1970) and by Smith (1975), which resulted in significant increases in the degree of self-actualization for students of education taking a single experimental course, were in no way contradicted. They were concerned with absolute effects of one type of course, whereas this study compared differences in effect between two types of course.

Although great care was taken to eliminate experimenter effects, the interpretation of the finding has to consider the fact that only one instructor was involved. The possibility of generalization is limited by the extent to which the characteristics of the instructor had a significant effect on the character of each course.

Comparing the ANOVA main effects of the independent attribute variables on ASTS and RATS, one notes significant main effects for SEPS, whereas sex and APS had non-significant effects. Thus, in a situation where SEPS and APS were subjected to dichotomies, only self-estimated proficiency in science was a predictor of anxiety specific to the teaching of science. Again, the result with respect to sex must be viewed against the background of a biased enrollment, and the possibility of generalization must be judged from case to case.

The results with regard to sex and APS were unexpected. The pilot tests measuring RATS had indicated that anxiety specific to the teaching of science would be greater for female students, and related research (Shrigley, 1974b) had indicated science knowledge to be important for positive attitudes.

The non-significant coefficients of correlation between sex and the dependent measures corroborated the finding, whereas the correlational analysis revealed significant associations to be present, after all, between APS and

ASTS (r = - .321) as well as between APS and RATS (r = - .417). The discrepancy between the results is seen as a consequence of the large number of scores near and on the APS median score of 14. When they were designated "high" and "low" respectively, small differences and random assignments suddenly became important; they could even combine to hide an effect that really was there.

Using the full information of the data, then, both SEPS and APS were significant predictors of anxiety specific to the teaching of science. In testing hypothesis 4, it was not possible to establish either as significantly better than the other. Based on the numerical values of the coefficients of correlation, in the multiple regression analysis SEPS was entered as the first predictor of ASTS, while APS was entered as the first predictor of RATS.

When the main hypotheses were tested for female students only, the significant effect of SEPS on RATS disappeared (Table 17). This does not mean that the effect was due to male students, but it was rather a consequence of the different cutoff point used to distinguish between high and low scorers. Tables 18 to 21 were given to show that the effect reappeared when the overall cutoff point was used. The example serves to exhibit the critical dependence of the results on the arbitrary cutoff point. With respect to the applicability of the Maslow theory of basic needs, it indicates that relative levels only (higher/lower) are insufficient, and that further criteria for establishing absolute need levels should be developed.

Major interest was focused on the possibility of significant interaction effects that would substantiate the need for parallel methods courses in the future. The results with regard to ASTS gave no indication of such effects. With regard to RATS, the conclusions based on dichotomies and those based on coefficients or correlations are partly different.

Using the pragmatic dichotomies, none of the interaction effects combining an independent attribute variable with type of methods course was statistically significant. In the multiple regression analysis, however, the interaction between the effects of sex and the type of methods course was significant, when entered as the second predictor of the RATS score. This finding in conjunction with the interaction in the two-way ANOVA gives some indication that the female students were better served by a traditional course, whereas the male students gained more from a humanistic course. However, since the ANOVA interaction was significant at the .1 level but not

at the .05 level, the evidence must be considered quite tentative. If the interaction is confirmed by future research, it would indicate self-actualization through teaching science to be a more realistic idea for male students than for female students. As the effect appeared in the RATS scores but not in the ASTS scores, it would also imply that, relative to other subjects, elementary school science is perceived as a "male" subject.

The results with respect to interaction effects were thus basically inconclusive. This was especially the case for SEPS, the main independent attribute variable. The very strong main effect was dominant, and in comparison with the level of SEPS at the beginning of the course, any measures of matching course to individual appear to have been of secondary importance.

Antecedent variables, i.e., sex and grade average on high school diploma, also showed strong correlations with the score on the final exam. Their persistent importance was a parallel to that of self-estimated and actual proficiency in the study proper. The type of methods course had no significant influence on the score on the final exam, which was expected since efforts were made to have a fair examination.

Implications

As almost no significant differential effects were found between the two types of methods course, a choice of fundamental philosophy for future methods courses in physics and chemistry must be based on determinants not included in the study. The most important one of those is likely to be the instructor. A matching of course type to instructor characteristics such as sex, experience of teaching, and degree of self-actualization might be easier to attain than matching to the group characteristics of the students.

One way of minimizing the anxiety specific to the teaching of science seems to be to raise the average level of the self-estimated (and actual) proficiency in science before the methods course. If this falls outside the reach of the teacher education institution, part of the methods course could be devoted to it instead. Such is the situation at the Faculty of Education at Abo Akademi, Vasa. It means emphasizing those elements of a traditional methods course that aim at basic competencies in science content. In a humanistic type of course it would involve the inclusion of enough personal objectives that directly aim at a feeling of proficiency in science.

There is no indication of a need for two different kinds of methods course at the Faculty of Education at Vasa. To some extent the information given by this study can be observed in a more effective kind of individualization within the organizational limits of either type of course. It would be based on better knowledge of the students by the instructor. The added dimension would mean knowing the self-estimated proficiency in science of each student.

The products of the study include much course material that will be of use in the future: the tests developed to measure SEPS, ASTS, and RATS, the Project Idea Bank, the Objectives Bank, the lectures, the attitude inventories, and other computer programs. A comparative evaluation of the activities remains to be done, but there should be material enough to choose only the best.

Additional related research suggested by the author includes the following:

1. Follow-up of the effects of the courses: As the students were in their first year of studies, there is ample time for long-term effects to show up even while they remain at the university. A suitable time for repeated use of the ASTS questionnaire and the instrument measuring RATS would be just before the last semester, when the students perform their evaluated student teaching. The instrument measuring RATS could be used sooner than that, to investigate the effects of methods courses in other subjects on the RATS score. Any significant changes could indicate deficiencies in the elementary education program, which would have to be corrected.
2. Further validation of the instruments used: This refers to the SEPS and ASTS instruments particularly. Application of the SEPS instrument in various types of population would be an altogether different line of research. With respect to the APS instrument, development of an instrument especially made for prospective elementary teachers could be a worthwhile alternative.
3. Investigation of the effect of the arbitrary cutoff point: A criterion for a useful choice of cutoff point in SEPS could be maximization of the corresponding interaction effect. With repeated application of the instrument, the cutoff points arrived at could be analyzed. A clustering at a certain score would be interpreted as an actual breaking point

between "higher" and "lower" need levels as used in the study. It would tie the SEPS quantitatively to the Maslow theory.

4. Investigating the effects of group homogeneity: In the present work, the groups included high scorers as well as low scorers. Group dynamics, including the support of peers, may give a different result in more homogeneous groups.
5. Investigating the effects of a closer relationship between the instructor and the students: Humanistic theories of education usually presuppose relationships that were not possible to obtain in this study because the instructor served as the researcher. Knowledge of the individual values on variables that proved to be important was lacking. With that information, the humanistic course might have had a different effect.

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APPENDICES

APPENDIX A

A SHORT ACCOUNT OF THE EDUCATIONAL PROGRAM LEADING TO ELEMENTARY SCHOOL TEACHER COMPETENCY AT VASA, FINLAND

The aims of the educational program within which the present study was conducted are to give the students the ability to serve independently as elementary school teachers, readiness to pursue further studies of education, and impulses to continous renewal in their professional work.

The program consists of general studies, subject studies, and advanced studies.

The aim of the *general studies* is to give the student a broad education including fundamental knowledge of society and the culture of man, basic studies of pedagogy, and skills of communication. They continue throughout the estimated four years of study.

The *subject studies* are subdivided into basic studies, specialized studies, and studies of pedagogy. The basic studies are scheduled during the first two years, the specialized studies during the fifth to seventh semesters, and the studies of pedagogy with their main emphasis during the fourth to seventh semester.

The basic studies are intended to give the students mastery of content and to provide methods of teaching the various subjects included in the elementary school curriculum. The methods course in physics and chemistry is given during the second semester. In the specialized studies, the students acquire deeper knowledge of two of the subjects. They may also choose to specialize in primary or special education. The subject studies of pedagogy are devoted to topics in elementary school education.

The *advanced studies* include methods of educational research, project studies leading to a master's thesis, and practice teaching. Research methods and the project studies are scheduled during the latter part of the program, whereas the practice teaching is divided into five periods of increasing inde-

pendence throughout the program. The last period, during the last semester, consists of evaluated performance in the practice (normal) school.

The estimated total amount of work associated with each course and each part of the program is calculated in study weeks, 40 weeks making a year of studies.

General studies: 35 weeks, including 15 weeks of pedagogy.

Subject studies: 85 weeks, subdivided into 39 weeks of basic studies, 30 weeks of specialized studies, and 16 weeks of pedagogy.

Advanced studies: 40 weeks, divided into 19 weeks of research methods and project studies, and 21 weeks of practice teaching.

The estimated amount of work associated with the methods course in physics and chemistry is 1.5 study weeks.

There are three other educational programs at the Faculty of Education at Vasa, one aiming at competency as a teacher of technical handicrafts, a second, corresponding one, for teachers of textile handicrafts, and a third devoted to educational planning and research. These programs have their general studies in common with the elementary education program, and they all lead to the degree master of pedagogy.

Furthermore, the Faculty offers the required studies of education for secondary school teachers of various subjects; separate studies in special education, counseling, and adult education; continuing studies of education in general; and graduate programs leading to higher degrees.

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APPENDIX B
SEPS QUESTIONNAIRE

Last four symbols of social security number: _____

PHYSICS AND CHEMISTRY QUESTIONNAIRE

This questionnaire measures your present estimate of your own proficiency in physics and chemistry. Please examine each statement in turn and decide to what extent you agree with it. Then circle the number

1, if you disagree with the statement.
2, if you disagree slightly,
3, if you do not know whether you agree or disagree,
4, if you agree slightly.
5, if you agree.

Thank you for your help!

1. I can read newspaper articles about physics or chemistry and judge if the conclusions are reasonable 1 2 3 4 5

— 2. I am not used to planning my steps in order to solve a particular problem 1 2 3 4 5

3. If a household gadget does not work. I can find out what is wrong with it 1 2 3 4 5

4. I am capable of drawing my own conclusions from observations and experimental results 1 2 3 4 5

- 5.	My disposition is not right for physics and chemistry	1	2	3	4	5
6.	I can apply my knowledge of physics and chemistry to explain natural phenomena	1	2	3	4	5
7.	I have a good foundation for learning more physics and chemistry	1	2	3	4	5
- 8.	It is unnatural for me to use terminology from physics and chemistry	1	2	3	4	5
9.	I can take notes of experimental results in a sensible way	1	2	3	4	5
- 10.	I cannot manage mathematical derivations in physics and chemistry	1	2	3	4	5
- 11.	I have difficulty reading texts that deal with physics and chemistry	1	2	3	4	5
12.	I can perform scientific experiments in everyday situations	1	2	3	4	5
- 13.	Laboratory work is unfamiliar to me	1	2	3	4	5
14.	I can apply my knowledge of physics and chemistry to explain how everyday devices work	1	2	3	4	5
15.	Ignoring my grades I would evaluate myself as good at physics and chemistry	1	2	3	4	5
16.	I can make systematic observations	1	2	3	4	5
- 17.	I am not used to predicting the results of experiments	1	2	3	4	5
18.	My knowledge of physics and chemistry helps me understand the society I live in	1	2	3	4	5

– 19.	I cannot solve practical problems using the formulae of physics and chemistry that I have learned	1	2	3	4	5
20.	I could be as good at physics and chemistry as most people if I wanted to	1	2	3	4	5

Note. Items marked with a – were scored inversely.

APPENDIX C
PRELIMINARY VERSION OF ASTS INSTRUMENT

SCIENCE TEACHING QUESTIONNAIRE

This questionnaire is a preliminary version of one intended to measure concerns specific to the teaching of science among preservice elementary teachers. Please describe how you feel about your future science teaching as exactly as possible. Be realistic – do not describe an imagined ideal situation.

On your answer sheet, blacken one oval for each of the ten questions.

A, if you agree with the statement,
B, if you agree slightly,
C, if you do not know whether you agree or not,
D, if you disagree slightly,
E, if you disagree.

The questionnaire is anonymous and in no way connected with your class work now. Thank you for your cooperation!

1. Many failing demonstrations would make the students doubt my qualifications as a science teacher.
2. If possible, I would let somebody else teach science in my class and take on some other teaching assignment instead.
3. I will have difficulty in adapting the classroom environment to science teaching.
4. Individualizing science lessons will be an easy matter for me.
5. I will have difficulty managing science lessons so that student discoveries are meaningful to them.
6. I will not be able to activate students whose interest in science is low.

7. Teaching science will require much more personal effort from me than teaching most other subjects.
8. I will be glad if my students ask me science questions I cannot answer.
9. I will tend to make science concepts too abstract for my students.
10. I will hesitate to make a scientific investigation in calss if I do not know how to explain the outcome.
11. There is a conflict between my teaching style and the way science should be taught.
12. I will be more successful teaching mathematics than teaching science.
13. I will feel embarrassed if I cannot handle the equipment the class is using.
14. I will be able to teach science without the support of a textbook.
15. I will know what topics in science are appropriate for different age levels.
16. The dangers connected with some equipment in use in elementary school science frighten me.
17. I will have difficulty in managing group work in science.
18. I will be able to present the nature of science in an appropriate way to my students.
19. I will not be able to explain many new products of technology to my students.
20. Teaching science will not be good for my self-esteem.
21. Other teachers will benefit from learning my methods of teaching science.
22. My science investigations will seem insignificant in comparison with the experiments of modern science.
23. I will have no difficulty in selecting good equipment.
24. I will not have time to prepare my science lessons adequately.
25. I would like to be more of an authority in my class than I feel I can be teaching science.
26. I will not have time to keep up with scientific progress as much as I should as a science teacher.
27. I will be able to explain many natural phenomena with understandable analogies.
28. I will have difficulty teaching students who are exceptionally proficient in science.
29. Students really should have a teacher more knowledgeable in science than I.
30. My degree of interest in science will be an asset when I teach science.

31. After teaching other subjects, the mental switch to teaching science will be uncomfortable to me.
32. If I let the students perform experiments on their own, I will be likely to lose control over the situation.
33. I see myself as a potentially successful science teacher.
34. If I do not understand a phenomenon completely, I will not discuss it to avoid spreading misconceptions.
35. I will be more successful teaching reading than teaching science.
36. If somebody is to observe my teaching, I would prefer they did not do so during a science lesson.
37. My own way of using scientific thinking will be helpful as a model for the students.
38. I hope somebody else will be responsible for the purchase of science equipment.
39. I will have difficulty preparing the science curriculum for the grade I teach.
40. I will quench much scientific curiosity by not being able to respond to it properly.

APPENDIX D
ASTS QUESTIONNAIRE

QUESTIONNAIRE CONCERNING THE TEACHING OF PHYSICS AND CHEMISTRY

The purpose of this questionnaire is to investigate how you now expect to function when you teach physics and chemistry within environmental studies. Please describe as exactly as possible how you feel about teaching it in the future, that is, what you think it will be like, and not what you wish it were like.

Circle one of the following numbers for each statement.

1, if you disagree with the statement,
2, if you disagree slightly,
3, if you do not know whether you agree or not,
4, if you agree slightly,
5, if you agree.

Thank you for your cooperation!

1. I will have difficulty in adapting the classroom environment to the teaching of physics and chemistry	1	2	3	4	5
2. I will have difficulty guiding students to discoveries in science that are meaningful to them.	1	2	3	4	5
+ 3. I will be able to activate students whose interest in physics and chemistry is low	1	2	3	4	5
4. My presentation of science concepts is likely to be too abstract for my students	1	2	3	4	5

	5. I will hesitate to make a scientific investigation if I do not know how to explain the outcome	1	2	3	4	5
	6. There is a conflict between my teaching style and the way physics and chemistry should be taught	1	2	3	4	5
	7. I will feel embarrassed if I cannot handle the physics and chemistry equipment the class i using	1	2	3	4	5
+	8. I will know what topics in physics and chemistry are appropriate for different age levels	1	2	3	4	5
	9. I will have difficulty managing group work in physics and chemistry	1	2	3	4	5
+	10. I will be able to present the nature of science in an appropriate way to my students	1	2	3	4	5
	11. Teaching physics and chemistry will not be good for my self-esteem	1	2	3	4	5
+	12. Other teachers will benefit from learning my methods of teaching physics and chemistry	1	2	3	4	5
	13. I will have difficulty in selecting good equipment	1	2	3	4	5
	14. I will not have time to prepare my physics and chemistry adequately	1	2	3	4	5
	15. I would like to be more of an authority in my class than I feel I can be teaching physics and chemistry	1	2	3	4	5
+	16. I will be able to use understandable analogies to explain natural phenomena	1	2	3	4	5
	17. I will have difficulty teaching students who are exceptionally proficient in physics and chemistry	1	2	3	4	5

+ 18.	My degree of interest in the subject will be an asset when I teach physics and chemistry.....	1	2	3	4	5
19.	After teaching other subjects, the mental switch to teaching physics and chemistry will be difficult for me.....	1	2	3	4	5
20.	If I let the students peform experiments on their own, I will be likely to lose control over the situation	1	2	3	4	5
21.	I will avoid topics that I do not understand completely, so as not to spread misconceptions	1	2	3	4	5
+ 22.	My own way of using scientific thinking will be helpful as a model for the students.....	1	2	3	4	5
23.	I will gladly let somebody else decide what kind of physics and chemistry equipment is to be bought	1	2	3	4	5
24.	I will have difficulty preparing the physics and chemistry curriculum for the grade I teach	1	2	3	4	5

Note. Items marked with a + were scored inversely.

APPENDIX E
INSTRUMENT USED TO MEASURE RATS

Last four symbols of social security number: _____

The purpose of this scale is to investigate how you think you as an ordinary teacher will manage teaching various elementary school subjects. Since certain subjects encompass parts of rather different nature, some names are to be interpreted in the following way:

social studies = citizenship + social studies + the parts of environmental studies that refer to "social life,"
biology = biology + the parts of environmental studies that refer to "living nature,"
physics/chemistry = the parts of environmental studies that refer to "matter and movement,"
gymnastics = gymnastics and sports.

In the list below, the subjects are compared in pairs. CIRCLE THE SUBJECT IN EACH PAIR THAT YOU FEEL *MORE INSECURE* ABOUT TEACHING. LEAVE NO PAIR WITHOUT A CIRCLE, AND DON'T CIRCLE BOTH SUBJECTS IN A PAIR.

Finnish – biology
physics/chemistry – geography
Finnish – technical handicrafts
music – gymnastics
history – religion
Swedish – technical handicrafts
English – Finnish
gymnastics – history
mathematics – gymnastics
mathematics – history
English – drawing
mathematics – drawing
text. handicr. – physics/chem.
social studies – drawing
physics/chemistry – mathematics
textile handicr. – biology

textile handicrafts – history	mathematics – music
social studies – mathematics	mathematics – geography
biology – gymnastics	textile handicr. – religion
Finnish – physics/chemistry	physics/chemistry – religion
. . . . .	. . . . .

The instrument contains all the 105 possible comparisons that can be made between 15 subjects.

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